Eng. Lit.

COMPRESSED AIR MAGAZINE

DEVOTED TO THE USEFUL APPLICATIONS OF COMPRESSED AIR

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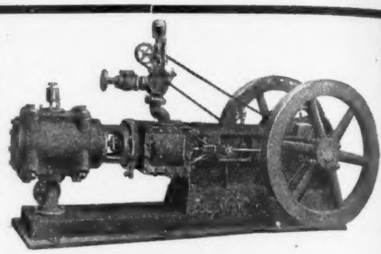
NEW SULLIVAN AIR COMPRESSORS



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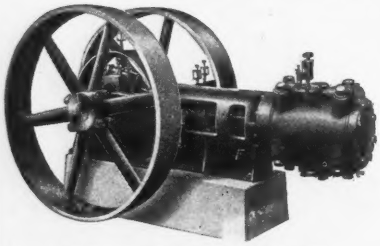

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INDEX TO ADVERTISERS.

SECOND EDITION, REVISED AND ENLARGED

COMPRESSED AIR PLANT

THE PRODUCTION, TRANSMISSION AND USE OF COMPRESSED AIR, WITH SPECIAL REFERENCE TO MINE SERVICE

BY

ROBERT PEELE

Mining Engineer and Professor of Mining in the School of Mines, Columbia University

As compared with the first edition the size of the second edition is increased 174 pages and the illustrations increased 97 figures.

The price is advanced from $3.00 (12/6 net) to $3.50 net (15/- net).

CONTENTS

PREFACE TO THE SECOND EDITION

This edition has been revised and substantially enlarged. Among the principal additions are some 90 pages of text and 63 illustrations, relating to the construction and operation of rock-drills, coal-cutting machines and channeling machines. This material is contained in Chapters XX, XXI, XXII, and XXIII. The detailed records of work of machine drills, in Chapters XX and XXI, I believe, will be found useful. Most of the data has not before been in print.

In Chapter III the theory of the compression of air is presented in greater detail, together with its applications to the operation and performance of compressors. The deductions of the more important formulæ are also given, such as those used for calculating the horse-power required for single- and multiple-stage compression. In this connection I desire to acknowledge the kind assistance of Professor Charles E. Lucke, of Columbia University, and Professor H. J. Thorkelson, of the University of Wisconsin. To Dr. Lucke my thanks are due for the use of his valuable, and hitherto unpublished, notes relating to the work cycles of air compression, with and without clearance. I would call attention also to the records of compressor tests in the latter part of Chapter X. These comprise a few typical tests, selected from a large number recently made by Mr. R. L. Webb, Mechanical Engineer, on compressors of different kinds in a well-known Canadian mining district.

Other new material has also been added, relative to the piston clearance of the air cylinders of compressors, and the ratio of inlet valve area to cylinder area. Numerous minor additions to the text have been made, together with corrections and alterations where required. The new matter aggregates some 135 pages of text and 87 illustrations. Many of the illustrations have been furnished by the respective makers of the machinery, to whom credit is duly given. In preparing this revision I have kept in mind certain kindly criticisms and suggestions received from readers of the first edition.

R. P.

NEW YORK, June, 1910.

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COMPRESSED AIR

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COMPRESSED AIR MAGAZINE

EVERYTHING PNEUMATIC.

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THE ENGINEER OF THE MINE HOIST

I don't want to boast nor nuthin',
But I've got this much to say;
If it wasn't for me that knows my biz
There'd be just hell to pay—
For I lowers the miners and hoists 'em too,
Some several times a day.

A human life don't count for much
When it's off in some foreign land;
But it means a lot when you're here on the hoist
With that human life in your hand—
And multiply that by the number on shift
And you'll see just how I stand.

A little mistake and they'd hit the sheaves,
Or land in the watery sump;
Or spatter around on the plates and guides
With nary a chance to jump—
But instead of that I lands 'em safe
With scarcely a jolt or jump.

I drops the cage to a station floor
So even and accurate, too,
That a car rolls on without a jolt
The way it was meant to do.
And when she is loaded I hoists her up,
Like a limited train goes through.

Now, I don't want to boast nor nuthin',
But, as I began to say,
I reckon a job like mine is worth
The price that the bosses pay—
For I hoists the miners and lowers 'em down
Some several times a day.

Berton Braley in Saturday Evening Post.

A SIPHON SPILLWAY ON THE BARGE CANAL

BARGE CANAL BULLETIN.

At three localities on the Champlain division of the Barge canal there are being built structures of a new type—intended to fill the office of spillway or waste-weir, and designed by Mr. George F. Stickney, Supervising Engineer. Two of these will discharge from the canal and into an adjacent stream the surplus waters that accumulate from an intercepted drainage area.

As a widely fluctuating canal water-surface is to be avoided, if possible, it is necessary to get rid of any surplus, and if this water may at times flow in rapidly, it must be discharged with equal rapidity. Ordinarily this has been accomplished by a waste-weir with sufficient length of spillway to pass the required amount in the given time. However, when the volume is large, the spillway must be long, and sometimes conditions exist which make a long spillway undesirable or even impossible. The presence of such conditions, especially in the case of one of these three structures—the one at Whitehall—has led to the designing and introduction of this new structure, a type which will perform the same amount of work as an ordinary spillway, but with a decided reduction in length, the ratio varying from one to three to one to five at these particular spillways, depending, of course, on the available head of water, while at the same time the economy in cost of construction is considerable.

These structures have been designated "siphon spillways." It is believed that in them the siphon principle is used for the first time to create a spillway of any considerable size.

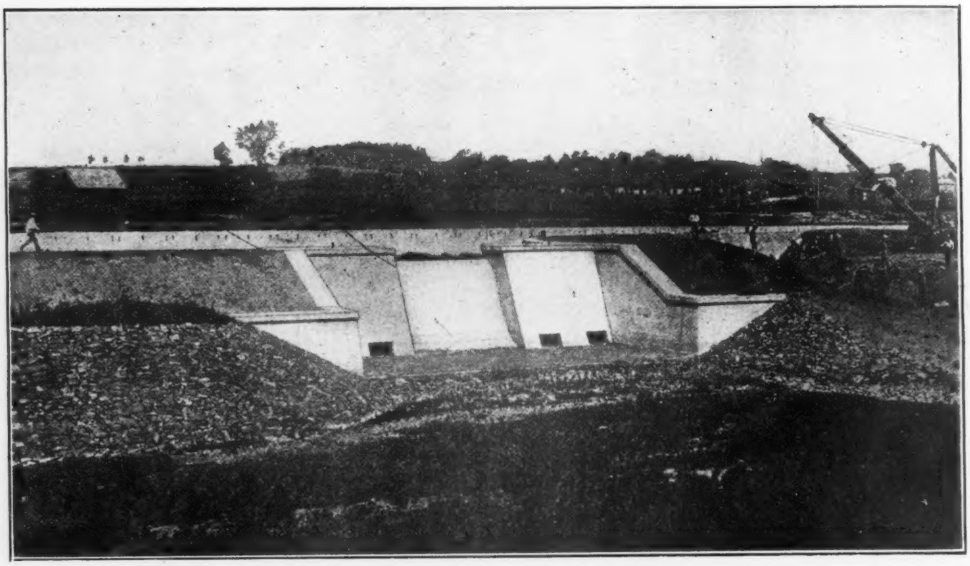


FIG. 1. SIPHON SPILLWAY AT SMITH'S BASIN.

The siphon action will be entirely automatic, in both the starting and stopping of the flow.

As previously stated, there are three of these siphon spillways planned for the Champlain canal. These differ in size and in the number of siphons employed. One of the spillways is at Whitehall, another at Fort Edward and a third at Lock No. 9, which is near the hamlet of Smiths Basin.

The Spillway at Lock No. 9 is completed. It is situated on the summit level of the canal and this level receives the drainage from a small area of adjacent land, the maximum inflow amounting to some 700 cu. ft. per sec. in times of heavy rainfall. It was desired to provide for this volume of flow and also to limit the fluctuation of water-surface to about one foot. The ordinary waste-weir of a capacity sufficient to take care of this flow, with a depth of only 1 ft. of water on the crest, would require a spillway 200 ft. long. The siphon spillway, however, measures but 57 ft. between abutments, and it accomplishes the same result. The structure consists of four siphons and a waste-weir 20 ft. long, the purpose of the weir section being to serve as a gap to carry off floating debris. Each of the siphons has an area of 7¾ sq. ft. Acting under a head of 10½ ft., each one will discharge approximately 160 cu. ft. per sec.; while the waste-weir, with a depth of 1 ft. of water on the crest, will have a discharge of 70 cu. ft. per sec., the total discharge for the whole structure thus being about 710 cu. ft. per sec. The inlet of the siphon is placed well below the water-surface and is protected by a screen to prevent the entrance of floating bodies that might happen to drift into the pipe and lodge in one of the several bends of the siphon. In order to reduce the loss of head

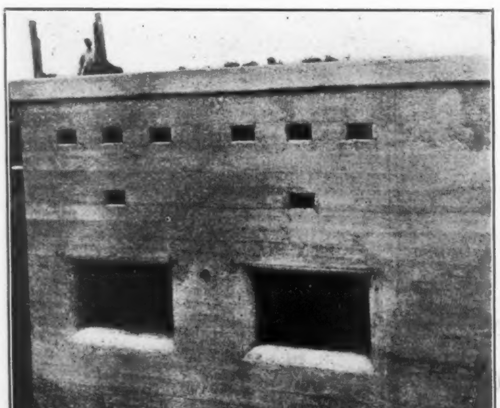
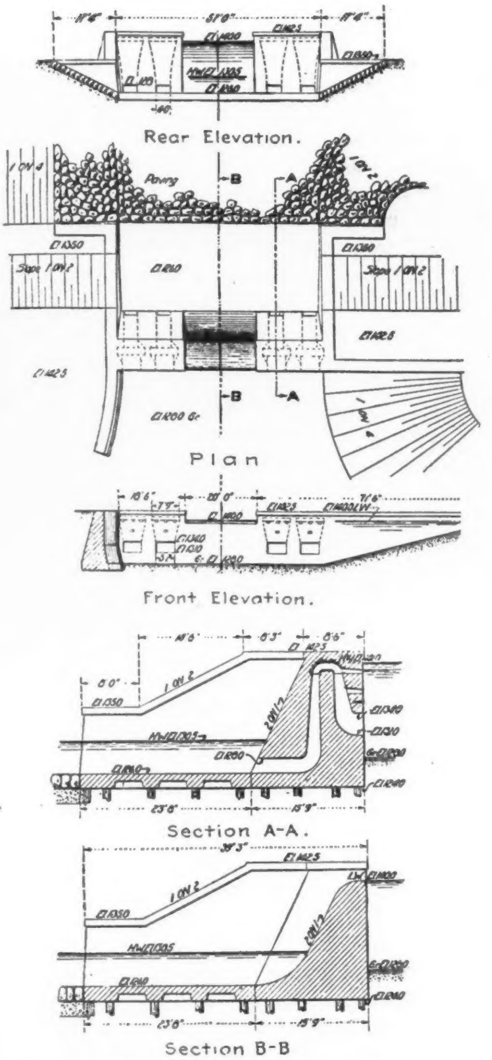


FIG. 3. INTAKES AND VENTS.



DETAILS OF SIPHON SPILLWAY.

due to entry, the inlet is flared out to double the normal area. As the siphon will not come into action until completely filled with water, it was necessary to limit the height at the crown to 1 ft., but the necessary area was obtained at this point by increasing the width. From the crown to the outlet the siphon is practically uniform in area, though the dimensions were changed from 1 × 7¾ ft. to 2 × 4 ft., in order to give a better section to the masonry and also to facilitate the removal of forms used in construction. At the crown, where the removal of forms would have been difficult, iron castings were provided, which were left in the masonry. Three vents, each 6 ins. high × 12 ins. long, pierce the wall at low-water level above the inlet of each siphon. When the water has been drawn down to this level, air will enter through these vents and stop the flow through the siphon. A little below these vents a single opening of the same size acts as a precautionary vent to break the flow in case the upper openings become clogged in any way—by freezing or otherwise.

DUST IN CITY AIR

By Dr. George A. Soper.

Closely associated with the bacteria in the causation of disease are the solid particles which air contains in the form of dust. A committee to which I happen to belong was appointed by the American Public Health Association to draw up standard methods for the analysis of air, and reported that the physical properties of the atmosphere are of more consequence to health than the chemical or bacteriological constituents, meaning thereby to place emphasis upon the importance of temperature and humidity, and especially upon the presence of dust, which contaminated air often contains.

Dust is directly or indirectly the greatest enemy of man. Aside from the enormous cost involved in the continuous warfare which is waged against it for the sake of mere cleanness, dust is dangerous to breathe. It is dangerous to breathe, not so much on account of the microbes which it contains, as because it is dust. Physiologists assert that nothing so predisposes the delicate structures of the nose, throat and lungs to invasion by microbes of respiratory diseases, and we can all bear testimony to the irritating and aggravating effect which a dust-laden atmosphere produces upon the sore throats and colds which most of us experience every winter.

It is probably the very commonness of the dust evil which makes us so indifferent to it, as we must frankly confess ourselves to be. We forget that it is composed of the offscourings of our bodies and the wear and tear of our clothing, habitations, shops, factories and streets, not to mention the comminuted refuse of our kitchens and the desiccated excrement of horses upon the public highways. We are

too indifferent to the way in which it floats in and out of our houses and contaminates the food we eat, the water we drink and the air we breathe.

Sanitarians have given much attention to dust, and have divided it into several classes according to its harmful effects upon the human organism. In the dusty trades, so called, the most destructive dusts are those whose composition is most unlike the soft and yielding structure of the respiratory apparatus. The grinding and polishing of metals, and the cutting of hard stone, are, because of their dust, among the most hazardous occupations in which a person can engage. "Grinders' rot" is a name popularly employed for the tuberculosis which commonly affects knife grinders before middle age. Pneumokoniosis is a longer and more scientific term by which the medical profession designates diseases of the lungs brought on by dust of whatever kind.

There are many dusty occupations, each with a startling mortality peculiar to itself. Upon investigation, the immediate cause of death is always found to be the same—tuberculosis and pneumonia. The direct cause of death is disease contracted from germs thrown off perhaps by a fellow workman; the indirect cause is a pair of lungs which have lost their normal resilience and peculiar spongy texture and have taken on a hard consistency and dull, somber hue from the dust which they have absorbed. The lungs of coal miners are black the lungs of men and women who have lived for some years in cities are gray, and the lungs of country people are a bright, healthy red.

Such being some of the conditions of contaminated air, let us glance for a moment at their remedy. We have found that the contamination of air, whether chemical, microbic or particulate, is due to its employment in some way for the use and convenience of man. Air becomes polluted just as water becomes polluted. In eash case a fundamental requirement of sanitary science is ignored. From its controlling importance and universal application we may term this requirement the cardinal law of sanitation. This law demands that waste products shall be carried promptly from their source, kept always within control and be inoffensively disposed of.

It is more difficult to observe this law in dealing with air than with water, and in no branch of sanitation will it be found possible to obey it perfectly. It is, nevertheless, our duty to keep its provisions prominently in mind, for no substantial success can be accomplished otherwise.

If the waste products of our furnaces and our factories were to be kept under control until they were utilized or otherwise destroyed, consider for a moment the immense saving in money and human life which would result. If persons sick with the lesser respiratory diseases, not to mention consumptives, were to isolate themselves as much as practicable, or, at least, refrain from visiting crowded assemblages, consider the enormous saving in life and health which would follow. If the filthy dust of our streets were to be kept from our lungs by efficient methods of street cleaning, consider the progress in decency and order, not to mention health, which this reform would accomplish.

The conservation of health has no better field for effective operation than systematic warfare against dust. With one notable exception, the use of oil on thoroughfares and railroads, no new method of combating this evil has been developed by sanitary science in recent years, while the quantities of dust produced and the harm which it has done have enormously increased with the growth of our cities. As matters stand, the greatest dust scavenger is the atmosphere. Into it we cast the dust of our houses with the same heedlessness with which we dump our sewage into the water courses. We do not stop to think that this air must serve to ventilate our dwellings and shops, and the lungs of our children and ourselves.

IRON DUST.

I found that there was produced in the New York subway one ton of dust for every mile every month from the brake shoes alone. At about the same time I estimated there was produced about a ton a mile a month on the elevated roads of New York. I did not take into account the wear on the rails or on the wheels. But so great was the wear on the rails in the subway that the Interboro Company had a special steel made for the rails. They got tired of renewing them.

The consumption of iron in New York, and the resolution of the metal into dust, is the most remarkable, most disfiguring element in

the city air. If you look at any of our white buildings, such as the Metropolitan Life Insurance Building, on Twenty-third street and Fourth avenue, you will see it is stained from top to bottom—stained yellow. It is stained much more deeply at the bottom than at the top. If you examine the Chemical Bank building on Broadway, you will find the same is true. But there the stain is more marked.

Our City Hall itself was cleaned by sandblasting about three years ago, and when I entered it to-day I was struck by the deep orange color of the lower part of the building. Now that is in the center of a little park. The iron dust produced by the wear and tear of trolley cars on the surface, of those of the subway nearby and of the elevated road, not to mention the great amount of iron dust from machinery and from horses' shoes, had been carried by the air to the City Hall, and there, by the aid of moisture, had become resolved into a yellow stain.

When the Metropolitan Life Building began to be stained, I discussed the question with some of the engineers and architects of that building, and suggested to them the cause of the trouble. It is one of the largest buildings in the city, and one of the most ornamental. Their view was that there was iron in the marble. But I went to Tuckahoe, where the marble came from, and found that houses had been built in the country not far from there of the same material and had stood many years without any stain. And then I collected dust from the Metropolitan Building—collected it on nearly every floor up to the top, which is a great distance from the sidewalk. I always found iron particles in the dust, and always in sufficient amount to account for the results. It would be an interesting thing for any one here who is at all concerned about dust, and curious to know how much iron there is floating around in the atmosphere he breathes, to scrape up a little dust,—perhaps from his book-case, or somewhere else in his home or office,—take a common ten- or fifteen-cent horseshoe magnet and pass it over the dust. Or, preferably, if the dust is scattered on a piece of paper, take the magnet and pass it back and forth under the paper. In the last case, with the magnet moving under the paper, the sharp eye will see some of the particles rearing themselves on their hind legs, so to speak, and waving back and forth in accordance with the amount of magnetic attraction beneath.

I have never found any dust in the city of New York that has not had iron in it. Unless dissolved by long-continued exposure to the weather, the particles retain their sharp, bladelike form.

There is a way to prevent much of the iron dust of the subway, and that way has been employed in the Central Underground of London. The Yerkes Tubes, of London, so called, have given up iron brake shoes and use a fiber brake shoe. These brake shoes are economical and prove an excellent remedy where such an amount of disfiguring dust is produced as in the New York subway.—*Journal of Association of Engineering Societies.*

COMPRESSED AIR FOR STIFFENING BEAMS, STRUTS, FLAT SURFACES

Prof. Perry, of the Royal College of Science, South Kensington, England, recently published a letter in which he called attention to the possibility of stiffening flexible materials by inflating them with compressed air, mentioning the bicycle tire and the long sausage-like india-rubber toy sold on the streets, as well-known examples. He suggested that the idea may be made very valuable in the design of metal structures, because with the proper internal pressure the compressive stresses can be reduced to zero. It is the compressive stresses that complicate structures and make bracing necessary that also greatly increases weight. The idea, now of special interest in view of the development of the aeroplane, is treated in Perry's "Applied Mechanics" in part as follows:

"A tensile load applied to extend a beam may not only diminish the greatest compressive stress, but also the tensile stress. Again, there are many cases of beams or infinitely flat arches in which there is no tensile stress anywhere. In such cases, of course, the earth takes the necessary tensile load. When the pneumatic wheel tire was invented, Prof. Fitzgerald pointed out that columns to support loads, and military bridges easy to pack and unpack might be made of inflated tubes, the solid material being everywhere in tension. . . . In a thin straight tube of circular section, if the greatest bending moment is M and

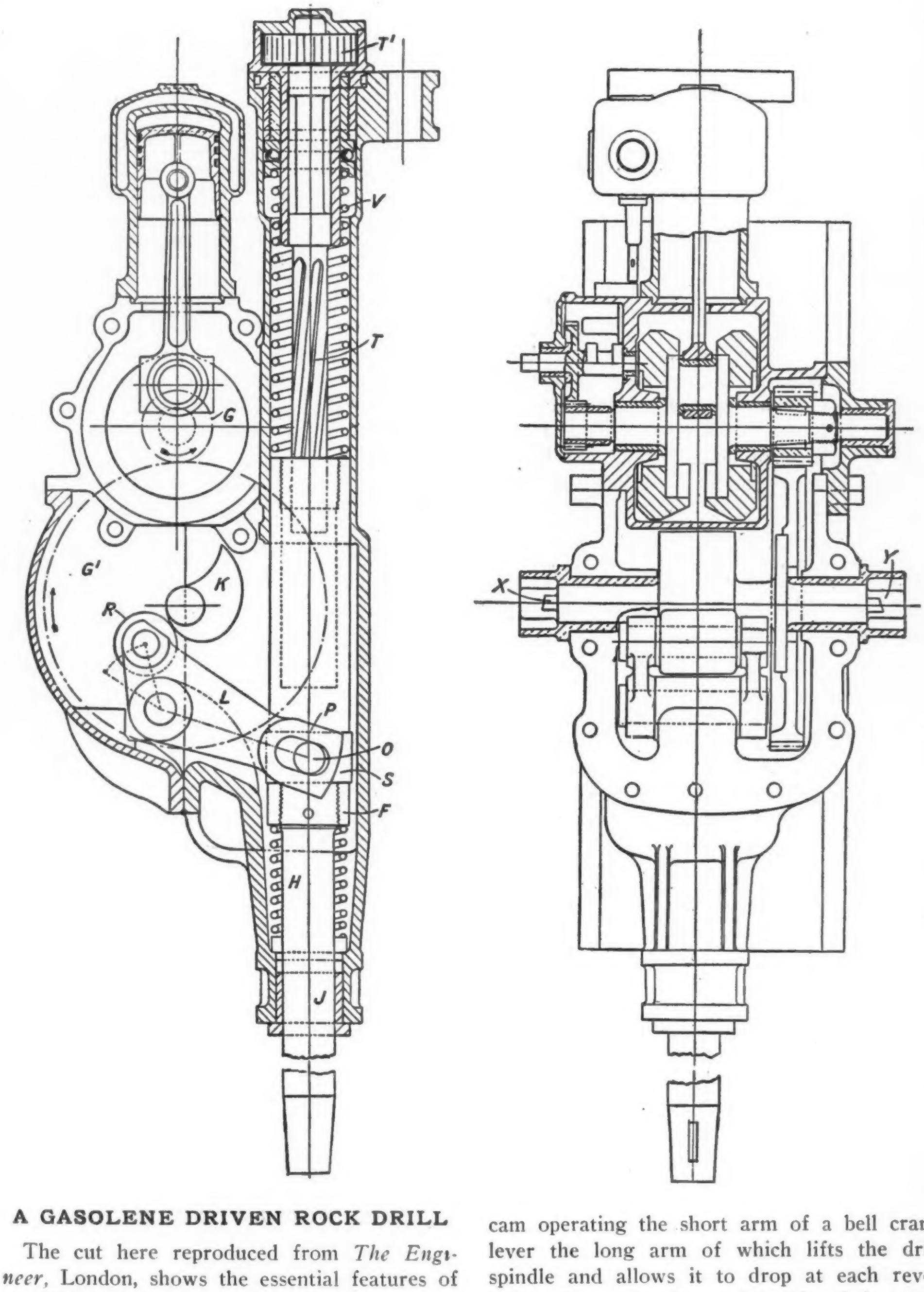
R is the radius, t the small thickness of the material, the compressive stress anywhere due to bending is $\frac{M}{\pi R^3 t} y$, where y is the distance from the diameter which is the neutral line of the section on the compressive side. The greatest compressive stress is $M / \pi R^2 t$. Now imagine the tube to be subjected to internal fluid pressure P above that of the atmosphere; there is a tensile end-long stress $P \pi R^2 \div 2 \pi R t$ or $PR/2t$, and hence the greatest compressives stress is $M / \pi R2 t - PR / 2t$. This is just o when $P = 2M / \pi R^3$. The greatest tensile endlong stress is then, of course, PR/t; but this is equal to the lateral tensile stress which the mere internal pressure produces. When, therefore, the internal pressure is just sufficient to remove all compressive stress in the material, the tensile stress, where it is greatest is the *same in all directions,* and is $2M / \pi R^2 t$. We see, therefore, that great loads may be carried by inflated tubes of thin material if they are only large enough in diameter, or by a bundle of small tubes. . . . One may go far in speculation on this idea—rigidity gained by using thin material and subjecting it to internal fluid pressure, so that there shall be no compressive stress. The great ships of the future may owe their stiffness and strength to the general use of fluid pressure in those parts of them where cargo is stored, and the same pressure which gives strength may serve to keep out the sea in case of a leak. It is the means by which the leaves of plants are made rigid. Similarly, large flat areas might be made of considerable size by fastening together two plane sheets by means of many connecting ties so that they may not balloon out, and then inflating them like an air cushion. Aeroplanes of sufficient size to support a man by Lilienthal's method can be made with comparatively small internal fluid pressures, and are not liable to make splinters when they fall to the ground, these splinters being a cause of considerable risk with aeroplanes made with sticks as stiffeners. Kites much larger than those suggested for military purposes might be made, in which the whole kite might be like an air cushion, or thin tubes with compressed air might take the place of the present bamboo framework. The inflation might be maintained automatically.

"Again, a thin tube of radius R and thickness t has to act as a column carrying a load W, and this is the load which is carried when there is no axial tensile stress. The pressure of the fluid inside being P, we have $\pi R^2 P = W$. Also the lateral tensile stress produced in the material is PR/t or $\frac{W}{\pi Rt}$, so that great loads may be supported by inflated tubes of thin material if they are large enough in diameter. Thus, for example, a tower of thin steel 1,000 feet high would have in it a lateral tensile stress of only three tons to the square inch, due to its own weight and the necessary fluid pressure. Being all in tension there is no danger of instability such as exists in ordinary pillars. If large in diameter, the hemisperical top cap becomes of importance as a load. Any moderate diameter like 20 feet would bear many tons on the top in addition to the weight of the structure itself. Thus, a tower 1,000 feet high and 20 feet in diameter and 0.01 foot thick would itself weigh about 125 tons. Its hemispherical cap would weigh 6.3 tons, and it would support 325 tons on its top. The internal pressure would be 23 pounds per square inch and the tensile stress 10 tons per square inch. There would be no compressive stress."

The fatal objection to most of the above would seem to be the necessity of an absolute guarantee that the pressure would be maintained, an apparent impossibility.

A SOUTH AFRICAN AIR LIFT VAT

At the Luipaardsvlei Estate a new type of air lift vat has been installed by Dr. Caldecott, consulting metallurgist to the Consolidated Gold Fields of South Africa, and is working most satisfactorily. The vat is employed for aerating accumulated slimes previous to treatment by cyanide. The vat differs from those erected in other mining fields of the world in that it is 30 feet high and 30 feet in diameter, whereas the usual type of air lift vat is 55 feet high and of much smaller diameter than the Luipaardsvlei installation. These tall and narrow vats have been very costly to operate, and the one employed by the Luipaardsvlei Estate Company, which has a capacity of 150 tons, has been proved to be a much more satisfactory device than the 55 feet vats with smaller diameter which have a capacity of only about 75 tons.



A GASOLENE DRIVEN ROCK DRILL

The cut here reproduced from *The Engineer*, London, shows the essential features of the Warsop gasoline rock drill, built at Chorley, England. There is a single-cylinder gasolene engine of not unusual type reducingly geared (4 to 1) to a shaft which carries a cam operating the short arm of a bell crank lever the long arm of which lifts the drill spindle and allows it to drop at each revolution, the gravity force of the blow being augmented by that of a long spring. The drill is mounted and fed and rotated by the usual devices, and being so self contained, or inde-

pendent of compressor or generator, if it could be thought of as delivering a blow comparable with that of the usual steam or air driven drill, or of the electric air drill, it would be entitled to respectful consideration.

PNEUMATIC TESTS OF PIPE*

Last spring two separate corporations wishing to put in some pipe lines that would be absolutely tight when laid and in service, ordered from two separate manufacturers a quantity of cast-iron pipe, each purchaser specifying in addition to the usual hydrostatic test that each pipe be carefully tested with air, compressed to 50 pounds per square inch, and that while under this pressure soap and water suds be applied so as to reveal open or porous iron or defects which the hydraulic test had not developed. Because of this additional test and it being known that air will, when compressed, work through metals more rapidly than water, it was determined by the manufacturers to use nothing but the best grades of iron that would give a close and uniform texture.

The results were that in one case there were 4,954 pipes tested either hydrostatically or pneumatically; of this number 27 leaked under hydraulic pressure and 272 leaked under pneumatic pressure, those leaking under pneumatic pressure having already passed the hydraulic test; this makes a percentage of leaks of the whole quantity tested 0.545 of 1 per cent. for the hydraulic and approximately 5.5 per cent. for the pneumatic, or slightly over 6 per cent. for the two tests. In the other case there were 2,737 pipes tested, of which 14 leaked under hydraulic and 186 leaked under pneumatic pressure, the percentage being 0.511 of 1 per cent. for the hydraulic and approximately 6.8 per cent. for the pneumatic, or about 7.3 for both. Analyzing further you will notice that the percentage of hydraulic leaks to the total number was but about 6.2 per cent. of the total number of leaks, taking both jobs together. This proportion, however, would undoubtedly have been more evenly divided had the hydraulic pressure in testing been maintained for a longer period of time per pipe, for, as previously stated, air compressed will find its way through open or porous metal more rapidly than water compressed, but in view of the fact that all of the pipes were to be subjected to an air test subsequent to the hydraulic, both manufacturers depended more on developing leaks with the air than with the water. While it is true that both lots of pipe were laid for the purpose of carrying gas, the writer believes that in these days when the tendency is with all water works to operate as economically as possible and with as little loss of the commodity being dealt in, for the purpose of conserving the supplies already in use to their fullest extent before looking for new sources, or in considering the most economical way of conserving new sources of supply which are being considered, we should all consider seriously whether requiring a longer hydrostatic test, or in addition to the hydrostatic a pneumatic test of the pipe we purchase and lay, would not be good economy, even at the risk of having to pay slightly more for our material. In other words, whether the best is none too good, both in material and in laying, while the first cost may seem high will it not effect economies of both operation and commodity that will eventually prove considerable of a saving?

*Paper before Central States Water Works Association by William R. Conard, Burlington, N. J.

COTTON MILL HUMIDITY

When the average temperature in a mill, as on certain days in June, is 75 to 80 degrees, Fahrenheit, with a relative humidity of 55 to 65 per cent., absolute humidity of 5 to 6 grains of moisture per cubic foot of air, it is generally recognized to be the best condition for textile working. Such days are neither remarkably warm nor remarkably humid; far less humid in fact than some artificially moistened rooms in many mills, but the humidity is steady.

No up to date mill manager needs to be told that a certain amount of humidity is necessary in textile working.

Most mill managers have learned by experience that during part of the year, unhappily short in New England climate, everything works smoothly, while at other times there is trouble.

The up-to-date mill manager wants to produce at all times if possible under the condi-

tions found in the fine June days when the work is at its best.

Doing this is essentially a matter of artificial moistening of the atmosphere. Various attachments are applied to the cards and other machines because of claims that these different devices strengthen the yarn. We have pointed out that any mechanism that will attenuate or give a combing action to the fibres of cotton will weaken them to a certain extent.

This statement is proven by the examination of the waste returned to the picker room, it being no longer flexible or coherent. The effect of humidity in a textile mill is far more complex than appears at first sight, because cotton slightly moistened works more smoothly than when dry or too wet, the fibres being more flexible and coherent when properly moistened.

Humidifiers are to a mill, what the experienced overseer who understands the structure of the fibre and its peculiarities, so as to be able to judge at the time of mixing whether the cotton will lose twist per inch or gain twist per inch, is to a room. Many mill managers blame the trouble due to dry yarns to electrification, which of course, is favored by a dry atmosphere; but this is erroneous. A dry yarn and a moist yarn are mechanically two different things, and electrification is only an incidental trouble which is easily overcome by the same means that soothes the mechanical trouble.

If the mill manager wants to secure a uniform production, which is generally the demand from our mill managers, the material must be worked under uniform conditions, and here is where the humidifiers are valued.

The mill manager, that will not have artificial moistening in the mill of which he has charge, is standing in his own light, because he should know that the shuttle that works well in an atmosphere of 55 to 65 per cent. of relative humidity will stick in the box and give trouble at 75 to 80 per cent. humidity, and will rebound when the humidity falls to 40 or 35 per cent.

The cards will run well in an atmosphere of 65 to 70 per cent., but will continually sag in an atmosphere of 80 to 85 per cent., and the web will follow the doffer instead of being stripped by the comb in an atmosphere of 50 to 40.

Of course, conditions vary so much in certain sections and certain mills that no fixed rules are universally applicable, besides, the carder, spinner and weaver are all apt to think that they cannot have too much moist air, and they sometimes run their humidifiers when they had better not, for too much humidity is as bad as too little. There is a device that will regulate this state of affairs and it should be used to control the humidifiers automatically, and not by the overseers, as is generally the case in most mills.—*Wool and Cotton Reporter.*

THE UNSTABLE EQUILIBRIUM OF THE BALLOON

BY TECUMSEH SWIFT.

The prominent and popular engineering problem of the day is that of aviation. It has attacked the mechanical brain of the age and must work itself out, to results perhaps not yet in sight. Probably more of the readers of the *American Machinist* are thinking and talking upon this topic than upon any other, and it would seem to be eminently improper, if not impossible, for their favorite journal to ignore it, so that I feel that I need not offer an apology for my say on the subject, my only regret being that what I can tell in my present lucubration is almost entirely about how not to do it. This is, however, the first and most necessary thing to know in any case. The earlier history of any laboriously wrought success consists largely of the story of elimination, and generally of the practical abandonment of everything first tried or thought of. The elimination of the essentially worthless devices in aviation means a saving of time, of money and of life.

Wonderful is the perfect poise of the fish in the water, yet the devices by which it is maintained, though marvelously ingenious, are of the simplest character. The most alert and swiftest fish of prey with which we are acquainted, such, for instance, as the pike or the pickerel, seem to spend much of their time almost absolutely without change of position, watching and waiting in readiness to dart, as upon land the cat watches the bird or the mouse.

A suberged body charged with life forces and floating inert in the water is apparently free to move or to be moved in any direction, and that it should not is the most unlikely thing that would probably be predicted of it;

yet fish seem to be provided with the means of resisting or of counteracting the minutest disturbing forces and to be able to maintain their position when so desired apparently without effort, and in fact almost automatically, so that they seem even to sleep as if anchored.

To retain its position vertically, so that it will neither rise nor sink in the water, the body of the fish as a whole must have precisely the same specific gravity as the water which surrounds it, and means must be provided, and they are, for instant adjustment and correction of the specific gravity. The air bladder of the fish, normally filled with compressed air, is a device for the purpose which for simplicity, precision and effectiveness challenges the inventive faculty to surpass it. The air in the fish bladder must be always under more or less pressure, and the elasticity of it opposes a constantly maintained muscular tension in the body which incloses it. When the muscular tension is increased the air is still more compressed, giving the bladder a diminished volume, and the entire body of the fish in which the bladder is inclosed is correspondingly reduced in bulk, so that while its actual weight remains constant, its weight relatively to the weight of water displaced is increased and the tendency of the fish-body is to descend in the water. On the other hand, if the muscles which hold the air bladder and its contents in compression are relaxed the body of the fish will be distended and the fish will tend to rise in the water. When fish are not well and have not the strength to maintain the compression they float to the surface. If a mermaid belle in a ball room of the deep should faint away she would not sink to the floor but would float to the ceiling and become entangled among the chandeliers.

The air bladder of the fish has a still more delicate and responsible function than that of merely maintaining the precise specific gravity of the body. The stability of the fish laterally in the water is assured by the fact that the air bladder is located high in the body and the preponderance of weight is below it. The longitudinal, or fore-and-aft, trim of the fish is more difficult to adjust and maintain, as builders and operators of submarines have learned. This also the air bladder perfectly provides for, it being made of considerable length relatively to its diameter and also partitioned transversely or formed into two chambers, the muscular control of the fish transferring air from one chamber to the other as may be required.

The fish floating in liquid of uniform and unchanging weight and destiny is thus perfectly equipped, with slight local adjustments by the aid of the fins, for maintaining its position and poise as desired. The problem of stability in the air is a still more difficult one, if not, indeed, impossible of solution, as we might learn by the hint which nature gives, all birds being of the "heavier than air" type.

Man, however, has not been deterred from trying it, and has had absurd experiences in consequence. More than a century ago balloon ascensions began and they still continue and it cannot be said that in all these years, and with the modern dirigible before us, much has been accomplished toward the attainment of the impossible in this direction.

The balloon ascensions with which the last century made us familiar were practically all alike. There was the gas bag and the helpless mortal in the basket below it. There would be too much gas to begin with and lots of ballast. Starting with levity sufficient to carry the balloon rapidly upward, so that it would clear all terrestrial obstructions, it would continue to rise beyond the desirable limit of flotation because the air in the bag expands correspondingly with the reduced atmospheric pressure outside of it. If the balloon was full to begin with some of the gas would be forced out of the neck, sometimes asphyxiating the aëronaut. Normally, however, the correct practice would be to let out some of the gas, continuing this until the ascent was stopped. By the time that it could be ascertained that the balloon had ceased to ascend it would really be descending with more or less rapidity and to check the descent ballast would have to be thrown out, this operation also being carried to excess before the results of the action could be determined. Then it would be let out more gas, then throw out more ballast and so on as long as the game could be kept up, the last result being always to come ignominiously to earth upon any spot which the shifting winds might determine, and never to be hopelessly lost in the sky. This certainty of coming to earth in the end has doubtless saved many more or less valuable lives.

While these ups and downs of the balloon were going on other agencies would have their persistent effects. There would be con-

stant changes of temperature, and consequently of the volume and levity of the gas, from the shining of the sun alternating with its obscuration from passing through different currents and strata of air. Sometimes the vast surface of the balloon would be dry and sometimes it would be heavily laden with moisture or actually wet with rain or even laden with accumulations of ice or snow, and then there would be more or less leakage or the interchange of air and gas continuous over the entire surface.

The dirigible balloon is still a balloon and subject to most of these balloon conditions and incidents. It is entirely balloon and only slightly a "dirigible." It must wait upon the fickle winds and can never oppose them. Under conditions the most favorable and seldom concurring it cannot at the best attain the speed of land conveyances. Of what possible use can it ever be except in some unforeseeable contingencies of warfare? For gambling purposes it would seem to be the ideal instrument, it involving so many elements of absolute uncertainty which can be neither predicted nor controlled.

While there are so many still scheming for perpetual motion, the balloonists, dirigible or otherwise, are not to be wondered at, but they would seem to be of the same type of visionaries, and suggest similar consideration and treatment.

The balloonist John LaMountain more than fifty years ago had a theory of an easterly air current which should carry him to Europe. He landed in the dense woods of the far northern Canadian wilderness, and he nearly starved to death before he worked his way out. Poor André started for the Pole, upon what theory nobody knows, and where he landed also nobody knows. At the present writing there is talk of flight to Europe by dirigible. While there is a law against suicide why should not such an attempt be preventable, at least until a flight of equal extent has been made over the land?

[The above article was written and presented before the start of the Wellman trip.—Ed.]—*American Machinist.*

Owing to the excessive humidity on the Canal Zone, good housekeepers there burn an incandescent lamp inside their pianos at all times to prevent the wires from rusting.

COMPRESSED AIR EFFICIENCIES

BY SNOWDEN B. REDFIELD.

It is fairly well known that the energy transformation in the use of compressed air is not high but the fact that it "does things," some of them better than by any other means and some which are not done by any other means at all, makes the matter of fuel economy of secondary importance. No apology is needed for the use of compressed air to-day.

That this matter of the fuel economy is not well understood is evidenced by the repeated appearance of propositions to develop the power of a water fall in the form of compressed air and transmit this through pipes to some distant point where its energy, like that of electricity, is supposed to be turned back again into work.

Such power-transmission propositions as this are utterly absurd because the losses in the compression and expansion of the air reduce the power efficiency to too low a point. These losses are not losses of pressure by friction, nor air by leakage, but simply losses due to heating and cooling.

It is not a difficult matter to prove that all of the work of compression goes into heat and is lost in pipe-line radiation. All of the work performed at the far end comes from the intrinsic heat originally in the air and the economy obtained depends entirely upon how the air is used. The actual cold compressed air traveling in the pipe does not at all represent the energy put into it by the compressor, as this has all been lost in radiation and the only answer to the question first expounded, is: "Nothing."

However, it is known that the air does work and this may be compared to the compressor work (although they have no direct relation) and in this way an "efficiency" may be stated.

As examples of machines using air with little or no expansion, rock drills and pneumatic tools may be cited and some interesting figures as to the efficiency of the power transformation, are given by the accompanying diagrams.

While actually indicating the drill or tool cylinder would be difficult, some rough idea of the indicated horsepower developed within it may be obtained by a little figuring, together with some judicious guessing.

Indicator diagrams of such machines would theoretically be rectangles, but wire drawing and cushioning effects of the valve mechanism would considerably modify this. It may be assumed then, reasoning from such a thing as a steam-pump cylinder, without cutoff, that the diagram factor will be about 80 per cent. In other words the actual mean effective pressure will be about 80 per cent. of what the theoretical rectangular diagram would give.

On this basis it is determined that a standard rock drill having a 3-inch diameter cylinder will develop about 6.2 indicated horsepower with 100 pounds at the throttle, this decreasing with the pressure supplied, down to about 3.7 indicated horsepower, with only 60 pounds pressure.

Comparing the probable indicated horsepower developed inside the drill cylinder with the actual compressor power required to furnish the air, gives the probable efficiencies shown by the chart. These efficiencies are referred to both the air and steam cylinders of the compressor, so as to give a basis for calculations for various methods of driving the compressor. They include 10 pounds pressure drop in the pipe line.

Referred to the air end of the compressor, it may be seen that with single-stage compression and 100 pounds pressure, about 23.5 per cent. efficiency is obtained, increasing to about 29 per cent. with the low pressure of 60 pounds. Compound air compression brings these figures up to 27.8 per cent. with 100 pounds and 31 per cent. with 70 pounds.

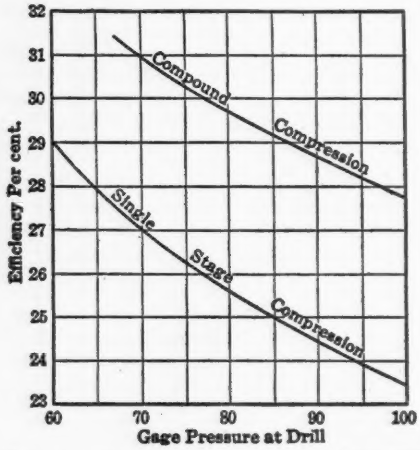


Fig. 1. Probable Efficiency Referred to Air End of Compressor

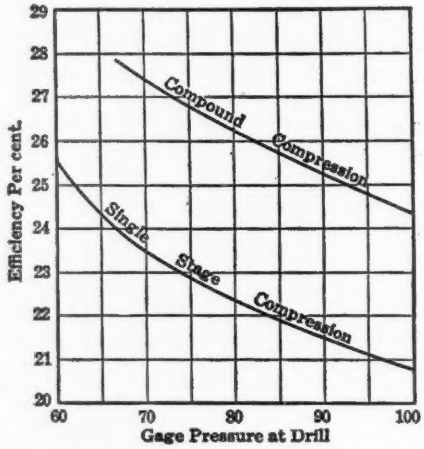


Fig. 2. Probable Efficiency Referred to Steam End of Compressor

A 3-inch rock drill will require about 138 cubic feet of free air per minute with 100 pounds pressure at the throttle; this decreasing to 90 cubic feet, with only 60 pounds pressure.

Knowing the quantity of air and the pressure, the compressor horsepower is easily calculated.

Thus, allowing 10 pounds pressure drop in the pipe, a 3-inch rock drill will require 29.8 indicated horsepower in the steam cylinders of the compressor with 100 pounds pressure and single-stage compression, or 25.2 indicated horse-power with compound compression. These figures reduce as the pressure used is reduced, but this, of course, reduces the work done by the tool.

Referred to the steam end, allowing 88 per cent. mechanical efficiency between the steam and air ends of the compressor, single-stage compression give a little less than 21 per cent. efficiency with 100 pounds and about 25.5 per cent. with 60 pounds air pressure. Compounding the air cylinders of the compressor increases these figures to about 24.5 per cent. with 100 pounds and almost 27½ per cent. with 70 pounds air pressure.

While these figures for efficiency have been determined for rock drills in particular, they apply equally well to almost any machine using compressed air without expansion. It must, however, be remembered that the figures are based upon indicated horsepower only,

both in the drill and the compressor. This is because of the impracticability of measuring the "brake horsepower" of the drill. If, however, brake horsepower efficiency is required, these figures for efficiencies of indicated horsepowers can be multiplied by the mechanical efficiency of the device using the air, say 90 per cent. or 80 per cent., as the case may be.

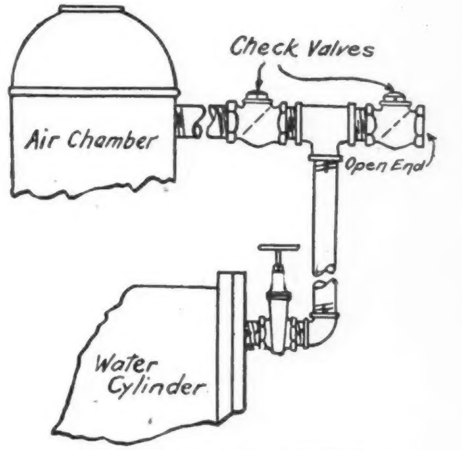
It is to be noted that the higher efficiencies are obtained with the lower pressures. This is because there is less loss by heating the air during compression, and therefore it is advisable to use pressures as low as is consistent with the size and weight of the machine required to do a given amount of work.

RESPONSIBILITY OF THE AIR CHAMBER

At a meeting of the New England Water Works Association the cause and cure of vibration or hammering in water mains at considerable distances from the pumps came under discussion.

A letter from Houlton, Maine, stated that the supply there was pumped by a triple geared pump with rawhide pinions, having a capacity of 1,000 gallons per minute. Although the valves were kept in good order, residences located on the two 10-inch pumping mains within 2,000 feet from the pumping stations were troubled by vibrations which sounded like the pump gears. This experience was found to have been more or less closely paralleled at a number of other places, and various methods had been adopted as remedies. One conclusion most commonly reached was that this vibration or hammering was caused by a lack of air in the air chamber, while others. attributed it to air in the mains or in the water cylinders of the pump. One pump manufacturer stated that he had had considerable trouble with the transmission through the mains of the noise of the gears where the pump was direct connected to the motor, which they had overcome by belt connections.

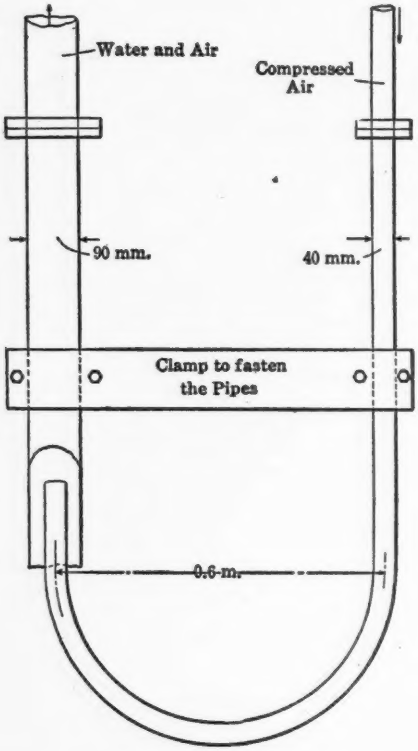
An extreme case was cited as existing at Orona, Maine, where the pump is run by an electric motor. In this case there is a pounding on the lines so great that some of the consumers are kept awake at night by it and a number of copper boilers have been burst although tested to 200 pounds pressure, whereas the water pressure is under 100 pounds. At



AIR SUPPLY FOR AIR CHAMBER.

Greenfield, Mass., a gauge was placed on the air chamber to indicate when this was full of water, which sometimes occurred about an hour after it had been filled with air. In order to keep air in the air chamber the water end of the pump cylinder was connected with the air chamber by piping on which were placed a gate valve and two check valves, as shown in the accompanying sketch. When the pump is running, if the gate valve near the water cylinder of the pump be opened, as the pump makes a suction stroke it takes in air through the open-end check valve, and on the return stroke this check valve is closed and the air is forced through the other check valve into the air chamber of the pump. A little water finds its way into the vertical pipe of this connection and travels up and down with each stroke of the pump, acting as a plunger. The gate valve opening is so regulated that a very small amount of air is taken in at each stroke; not enough to be drawn down into the water cylinder. At Hingham, Mass., likewise the air chamber was found to fill with water, and there the air was replaced by connecting the chamber by a pipe with the compressed air starting outfit which formed a part of the gas-engine plant.

Russian lineal measure is as follows: 1 totchka equals 0.01 inch; 1 liniia, 0.1 in.; 1 vershok, 1.75 in.; 1 archine, 2 ft. 4 in.; 1 sagene, 7 ft.; 1 verst, 0.66287 mile. Measures of area are 1 square sagene, 49 sq. ft.; 1 dessiatina, 2.6997245 acres; 1 square verst, 0.43940829 square mile.



THE AIR LIFT IN A MINE SHAFT

A correspondent of the *Engineering and Mining Journal* thus describes the arrangement employed for the unwatering of a mine shaft in France. We add a few of the English equivalents of the French measures.

"A simple air lift can be quickly set up to unwater mine shafts. The accompanying sketch shows the arrangement of the piping. In the mine where it was used 40-mm. (1.5 in) and 90-mm. (3.5 in) pipes were at hand and, as the necessity of unwatering a certain shaft on the property was urgent, no time was spent in an effort to improve the efficiency of the appliance by tapering the ends of the pipes. Air was delivered at an effective pressure of 65 lb. per sq. in.; the vertical length of the 90-mm. water pipe was 40 m. (131 ft.), and its horizontal length 300 m. (984 ft.). The results were as follows: With a submergence of 30 (98 ft) to 35 (116 ft.) m. and a lift varying up to 5 m. (16 ft.) the output was over 200 liters (53 gal.) per min.; with a submergence of 14 m. and lift of 21 m. the output was 50 liters, and with a submergence of 11 m. and a lift of 24 m., it was only 30 liters. The output decreases, therefore, as the height which the water must be lifted increases.

"Although the efficiency of the system is not high, it presents valuable advantages for emergency use, as it can be quickly installed, does not require any attention, oiling nor, as does a pump, adjustment for every 7- to 8-m. variation of the head under which it is operating.

In the case of a deep shaft this appliance might be used to assist the sinking pump, which would then require to be lowered only for 25- or 30-m. reduction of the water level."

It is rather queer that this writer did not use the metric figures for the air pressure the same as for all the rest of it.

BALLOON GAS

Balloon gas is the more valuable as its specific gravity becomes less. The gas for the recent Indianapolis balloon race had a gravity of 0.38 (standard conditions). Dr. Oechelhaeuser, general manager of the Dessau (Germany) gas works, says that German coal gas has a gravity ranging from 0.36 to 0.53 or an average of 0.41, while he has made balloon gas at Dessau having a specific gravity of 0.225 to 0.3 (average 0.27), air equaling unity. This gas is obtained by subjecting coal gas to a high temperature in either a horizontal or a vertical retort, which reduces the methane in his coal gas from 24.7 to 6.9 volume per cent. and increases the hydrogen from 59.6 to 80.7. The coal gas is subjected to a temperature of over 1,200 deg. C. by passing slowly through retorts filled with coke to increase the heating surface; a 10 ft. retort converting about 353 cu. ft. per hour at a cost of 12.5 cents per thousand for firing, or a total of 21 cents, but as the volume increases 20 per cent., this becomes 17 cents, although other charges will bring the extra cost up to 20 cents. The gas is air-cooled after coming from the retort, the dust filtered out, run through an oxide purifier and into a holder. He says that a balloon holding from 42,360 to 44,480 cu. ft. weighs with net, basket, charts, anchor, rope, etc., about 865 pounds and carries three persons weighing 620 lbs., not counting provisions or blankets, also 18 sand bags weighing 44 lbs. each or 440 lbs. of ballast, a total of 1,925 lbs. to lift. If the balloon can be filled with a

0.27 gravity gas instead of say a 0.37 gravity gas it will lift more to the extent of the difference or 10 per cent. of the air displaced, if of 4,300 cu. ft., say about 326 lbs., which will permit of so much more ballast being carried, and that is a big item in a balloon race.—*Progressive Age.*

COMPRESSOR COMPUTATIONS FOR A MINE PLANT

Two students of the Colorado School of Mines, Mr. J. W. Whitehurst and Mr. W. P. Cory, Class of 1910, prepared as a graduating thesis a design for a complete mine plant. The thesis was also prepared in competition for a prize offered by the Mining and Scientific Press, of San Francisco, which prize it secured.

The problem presented was to design and lay out a plant and select machinery and equipment for a mine operated through a 1,000 ft. vertical shaft. The altitude was approximately 10,500 ft. above sea level. The excessive cost of fuel at the mine favored an electrical installation, current to be bought from an independent company. Several other details were specified, but as we have to do here only with the compressed air, these are not given. What follows is from the thesis above mentioned.

It is proposed to use compressed air for drilling during a period of 16 hours, two 8-hour shifts, loading and shooting to be done during the remaining shift. Assuming that a 2¼ in. piston drill will break 10 tons of rock in an 8 hr. shift, it is found that the approximate number of drills required will be as follows: Rock to be broken per 16 hours=225 tons; capacity of one 2¼ in. drill for 16 hours=20 tons; number of 2¼ in. drills necessary, 11.25. These drills are to break all the rock to be hoisted in the mine; the waste broken by drills doing development to be used to fill open stopes. The 2¼ in. drills are equivalent to 68 per cent. of 3 in. drills, and hammer drills to 36 per cent. of 3 in. drills. These two constants are based on the relative air consumption of the drills. The drills cannot be operated continuously, due to loss of time in setting up and changing steel. Hammer drills require scarcely any time to set up and change steel, and therefore this consideration is not necessary. With the equivalent of a total of 8.3 three-inch drills in operation at one time, each requiring 125 cu. ft. of free air per minute at a pressure of 90 lb., a total of 1038 cu. ft. of free air (62° F. and 14.75 lb. pressure per square inch) is required at the drills; the operating pressure at the drills to be 90 lb., gage.

The barometer at the mine reads approximately 20.39 in., equivalent to 10 lb. per square inch absolute pressure. This may be corrected for altitude as follows:

$$\frac{14.7\times 1038}{10}=1525 \text{ cu. ft.}$$

To estimate the air required, allow 10 per cent. loss in transmission through the pipes, then there will be required:

$$\frac{1525}{.90}=1694 \text{ cu. ft.}$$

under atmospheric conditions at the discharge valves of the compressor. Allowing a loss of 5 per cent. for imperfect valve action and heating of incoming air, there will be required taken into the compressor per minute:

$$\frac{1694}{.95}=1783 \text{ cu. ft.}$$

under atmospheric conditions. To allow for loss of pressure in transmission it is considered that the final discharge pressure at the compressor is 95 lb. gage. It is better therefore to select a two-stage machine. The absolute discharge pressure of the low pressure cylinder should be:

$$\sqrt{10\times 105}=32.4$$

absolute. It is assumed in this computation that there is complete cooling between the stages and equal distribution of the work.

Assuming 2 per cent. clearance, the factor of clearance becomes,

$$F=1-\frac{2}{100}\left|\frac{32.2}{10}\right|^{0.712}+0.02=0.974$$

The factor of clearance is equivalent to the ratio of the displacement of the piston to the total value of the cylinder. Then the displacement of the low-pressure cylinder is:

$$\frac{1785}{0.974}=1832 \text{ cu. ft. per minute.}$$

Assume a 24-in. stroke with the compressor running at 150 r.p.m. Then the displacement per stroke of low-pressure cylinder is:

$$\frac{1832}{2\times 150}=6.106 \text{ cu. ft.}$$

and $\frac{6.106}{2}=3.053$ sq. ft. = area low pressure cylinder. Diameter of low-pressure cylinder, approximately 24 in., and 13.4 in. diam. of high-pressure cylinder; indicated horse-power of air cylinders is 218. Allowing 77 per cent. for combined efficiency of motor and compressor,

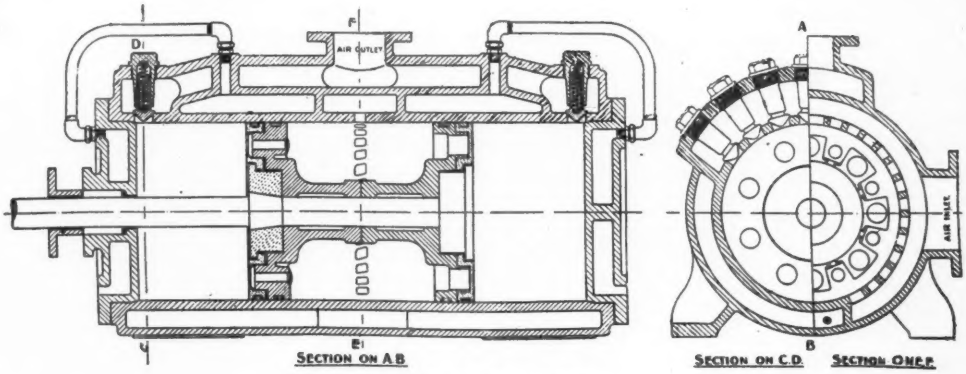
$$\frac{218}{77}=283 \text{ hp. required for motor.}$$

From the above data a belt-driven 2-stage compressor has been selected. The compressor is to be driven by a 440-volt, 60-cycle, 3-phase, 285-hp. induction motor running at 600 r.p.m. with a driving pulley 30 in. diam. The belt is to be extra heavy double-ply leather, 21 in. wide. This compressor is rated at 1885 cu. ft. free air per minute at 95-lb. gauge pressure, which corresponds closely with calculations.

Air should be supplied to the low-pressure cylinder at as low a temperature as possible to secure greatest efficiency. There is an increase in volumetric efficiency of 1 per cent. for every 5°F. reduction in temperature of entering air, below that of the engine room. To accomplish this, a wood conduit 2 by 2 ft. is led from the inlet valves of the compressor to a point under the eaves on the north side of the building. Receivers are not so much for the purpose of storing the air, thus acting as a reservoir of energy, as to partly cool the air and free it from moisture before entering the main pipe-line, and to reduce the pulsating effect produced by the operation of the compressor. With these objects in view a 36-in. by 8-ft. upright receiver is to be erected. A second 30-in. by 5-ft. receiver is to be placed at the seventh level station to supply the seventh and eighth levels by means of suitable and separate 2-in. pipe-lines. A third 30-in. by 5-ft. receiver is to be placed near the pump station on the tenth level, supplying the ninth and tenth levels through 2-in. pipe-lines. The pipe, from compressor to receiver, is placed in a conduit, one foot square, in the cement floor; the floor at top of the conduit is recessed for receiving a cast-iron cover. From receiver to shaft the pipe is buried 18 in. underground. In the shaft the pipe is supported every 10 ft. From compressor to seventh level the pipe is 5-in. inside diameter; at this point a 4-in. branch line runs to the receiver and the main line, reduced to 4-in., extends to receiver on tenth level. All piping is to be standard weight, lap-welded mild steel, with flanges screwed on and supplied with suitable rubber gaskets.

PRACTICAL PIECEWORK

There is no system like piecework with the class of men we are getting to-day. You get up here and say you have 200 machinists. What do you do with them? You are spending a lot of money in looking after those machinists, but when you put the men on piecework you do not have to do so. We have an assistant general foreman who times all new operations. The men get so that the minute they get hold of a new job they look him up and say: "Come and time the new job that I have." We have never cut the price in Cleveland with the exception of where the company has spent money in buying new tools. We endeavor to be fair to the men and fair to the company. We do not work piecework on a job until the piecework schedule has been signed by five men—the assitsant general foreman, the general foreman, the master mechanic, the shop specialist, and the mechanical superintendent. And the price cannot be changed without the consent of the five people that signed the cards. I do not know of a place where the price has been cut for three years.—*J. A. Boyden at the General Foremen's Convention.*



A NOVEL PISTON INLET.

AN AIR COMPRESSOR CYLINDER

The cut on this page shows sections of an air compressor cylinder as built by John Wood & Sons, Ltd., Wigan, England. The unusual feature is in the system of air intake. It will be seen that the cylinder is abnormally long for the piston stroke, and that the piston faces are widely separated, or in fact comprise two pistons fixed upon the same rod. There is an intake air passage surrounding the middle of the cylinder with numerous radial openings direct into the cylinder. The face of each piston carries a large annular valve of slight movement, covering liberal openings through the piston. This valve is quite heavy and is provided with a regular packing ring, which fits the periphery of the cylinder, causing friction which operates the valve, opening or closing the piston passages upon each reversal of the stroke. This arrangement permits most complete water jacketing.

DESPERATE PLIGHT AND DARING RESCUE OF A DIVER

One of the horrifying experiences which are not infrequently the lot of the submarine diver, came recently to Frank H. Nystrom, working in a trench in which a large gas main was to be laid in the bottom of the Harlem River, near Second Avenue, New York City. He was in the regular diver's dress, working under a pressure of probably 15 pounds. His work at the time was the feeding of the loosened material to an 8 in. pipe of a suction dredge. Some obstruction occurred and, while feeling about to find the trouble, the upper crust of the trench suddenly caved in, burying him to the waist, but, worst of all, one or two big stones pinching his foot and holding him fast. The details of his experience follow, as told to a reporter of the *New York Times*:

"I realized it would be folly to signal my comrades above to haul me aloft. If they could have done this they would have torn my leg from my body. But at last I took a chance and pulled the emergency cord, sending up a signal of danger and distress. A response came swiftly that help was coming.

"That made me feel better. I believed it would not be a hard matter for companion divers to dig me out, and lift the rocks from my foot. Presently I distinguished against the black fog of the river the faint glimmer of the lamp of a diver's helmet. I watched him eagerly as he made his way toward me. It seemed to me he came painfully slow. He had in his hand a pick and shovel.

"The diver paused near me, and seemed to be taking in my situation. He did not seem exactly to like the look of things. Finally he came a little closer, and began to dig away at the sand in the trench. But he didn't do any good. As fast as he dug out the sand it was swept back into the trench by the water.

"There is a way that divers have under water of communicating with each other. It is by pressing together the heads of their copper helmets. Then their voices can be clearly distinguished. I extended my arm toward my companion in the manner of divers wanting to have verbal communication, but he recoiled at my touch and backed away from me.

I made beseeching gestures for him to come near me. He stood viewing me at a safe distance.

"When I saw it was useless to try to induce him to return, I sent up another distress and danger signal, more urgent than the first. Presently another diver appeared. Like the first diver, though, he was afraid to venture very near me. I could see that they were afraid I would grab them in the iron grip of a desperate man, and that they were afraid of sharing my fate in the trench. I called, cajoled, and pleaded to them in the language of the submarine diver, but they refused to come near me.

"Then I sent up another call for assistance, and a third diver was sent down. He, too, like the others, would have nothing to do with me.

"The sand and the pebbles that enveloped my body from the waist down, squeezed me tight, and the blood in my temples was throbbing until I thought my head would burst. I had been in an upright position for what seemed an eternity, and my strength was rapidly leaving me. The tide gurgled by me, and between the pressure of clay against my body and the pressure of water above me I thought I must soon collapse.

"And all the while, grimly watching me, but afraid to touch me, stood my fellow-divers.

"How long I stood this way I do not know. But at last another diver appeared on the scene. I found out afterward it was John Anderson, the foreman. He came to me with none of the timidity that marked the other divers. He walked right up to me, and when I started to lay my hand on his shoulder to signify I wanted to talk to him, he did not draw away as if he were afraid I would drag him down.

"We put our copper helmets together.

"'For God's sake.' I shouted with all the strength left in me, 'help me to get out of this.'

"I told him if he would get a knife and cut my diving shoe off my foot I thought he could pull me out. The knife was soon forthcoming. He dug away the sand and pebbles and cut the strap of the boot. Then he gripped me around the waist and pulled me out of the grave that had held me prisoner for four long hours. And now I am home again."

VARIOUS ICE FORMATIONS

Dr. H. T. Barnes, professor of physics at McGill University, Montreal, has peculiar facilities for the study of ice, on account of the close touch with the St. Lawrence. The subject is of much importance in the neighborhood of Montreal on account of the serious floods which occur, caused chiefly by the ice. In a paper before the New England Water Works Association, Dr. Barnes gave interesting information derived from his investigations.

SURFACE ICE.

In a lake or river not flowing with sufficient rapidity to produce serious eddies, with the advent of cold weather and the approach of the water temperature to 32 degrees Fahr. there is a tendency to form ice. Depending to a large extent on the vagaries of climate or direction of wind, the ice forms first along the shores, and gradually extends out on all sides. Several conditions must hold before the surface can be entirely covered. The water must be at or very near the freezing point, the air temperature must be at or below the freezing point and the wind must be practically zero in order that no ripples be produced.

Atmospheric humidity determines very largely the growth of the first ice cover. A dry wind will produce rapid evaporation and a consequent rapid absorption of heat. In a cold atmosphere the air over the water is warmed and is in consequence capable of absorbing more moisture than it can hold when blown away to colder parts. Hence the characteristic steaming of open water or thin ice which is observed when the atmosphere is in the neighborhood of 10 degrees Fahr. The exact temperature of the water also plays an important part in the formation and growth of surface ice. With water exactly at 32 degrees Fahr. ice will thicken indefinitely as long as the air temperature is below the freezing point, but it seldom happens sthat the water is exactly at 32 degrees Fahr. under an ice sheet. It is usually 0.01 degrees or 0.02 degrees above freezing and the influence of this is to produce a limiting thickness to which the ice will grow, or in other words a balance is finally produced between the heat carried away by conduction through the ice and heat supplied by convection

streams of water slightly warmer than 32 degrees Fahr. which bathe the under surface of the ice sheet. If the water is higher in temperature, due to bottom streams being deflected upwards by shoals or to warm springs, then no surface ice may form at all.

The position of the first ice crystals is along the surface of the water, but as soon as formation proceeds as a result of conduction of heat through the ice then the ice crystals are all orientated with their principal axes at right angles to the water surface. It has been indicated by previous experiment that an ice crystal conducts heat best in the direction of the principal axis and the fact that all such crystals turned so as to transmit the heat of the water most readily indicates that this is so. The difference between conduction ice and conglomerate ice, that is, ice formed by the freezing together of irregular masses, is very great when considered with reference to their power of disintegration. Salt water ice is a notable example of this, and the masses of such ice not being regular in crystalline structure take a very long time to melt. There has been very little, if any, scientific work done in studying the rate of growth of surface ice and the data available are practically useless.

The main factor in surface formation is the conduction effect, but the rate of growth is affected by convection currents in the water, humidity of the air, which influences the evaporation, and the velocity of the air currents over the ice. Radiation is a small factor which comes into the calculations, both a gain of heat from the sky and loss of heat from the ice surface to the air. Accumulations of snow on the surface produce an uncertain factor, but nevertheless an important one which may be corrected for when the depth of snow is known.

FRAZIL ICE.

Wherever a river flows too swiftly for surface ice to form into a sheet it remains disintegrated in small crystals and is carried down by the current. On account of the smallness of the crystals they have little buoyancy and are therefore easily swept under by currents. The amount of frazil, as such ice is called, (*frawzeel,* if you please) that is formed depends on the mean air temperature, but more on the degree of agitation of the water. Thus in a rapid, where the water is intimately mixed with the cold air, a great deal of frazil is produced, which becomes troublesome at times and is the cause of winter and spring floods on many rivers. It is swept by currents under the surface ice which is formed in the quieter parts of the river. Then it floats up to the underside of the surface sheet and freezes, building down great hanging dams that become as impervious to water as so much rock. The natural river channel is restricted and in consequence the winter level is much higher than in summer.

Although this ice is formed most rapidly on the surface it appears also throughout the body of the river when the water is supercooled. The supercooling is never more than a few thousandths of a degree, but notwithstanding this produces great physical effects. It is during such a time that the ice becomes adhesive, agglomerated and produces trouble to the operators of water powers. The strength and tenacity of the frazil so long as the temperature remains below the freezing point is enormous. It wants but the very smallest change of temperature in the water, however, to make it soft and sponge-like and easily disintegrated. The sun is the most powerful agent in imparting the necessary small fraction of temperature to the water to relieve ice troubles. Thus water wheels which have been securely cemented during the night are soon running again the next day when the sun comes out. Artificial methods of heating have been developed which have proved remarkably successful.

ANCHOR ICE.

The formation of ice on the bed of a river which is not frozen over has been observed for many years. In America it goes by the name of anchor ice and in Europe as bottom or ground ice. There has been much discussion over the cause of its formation. It has now been widely accepted that it grows on the surface of objects immersed in water which is slightly supercooled and flowing too fast to freeze over. On clear cold nights it is found growing more rapidly than on cloudy ones and it is observed to form on dark rocks faster than on light colored ones. Terrestrial radiation is therefore responsible for much of the ice, and in addition vast quantities of frazil crystals are frozen to the bottom ice after having been carried down by currents. With the water above the freezing point no anchor ice can form. It has never been observed to grow on the bottom under surface ice. When-

ever it has formed previous to surface ice it is dislodged as soon as the cover forms and rises up to become attached to the under side of the surface sheet.

The sun has a powerful influence in preventing anchor ice formation and in melting it off when once it has formed. It is a well-known sight along the St. Lawrence on a clear cold morning in winter to find great masses of ice rising from the bottom as soon as the sun's rays can penetrate into the water. These masses have been attached to the ground and by growing in size have exerted greater and greater buoyant force on the rocks. Some of them come up bringing masses of rock with them purely by their own force. Boatmen on the river are very careful not to go out when the ice is rising for fear of being surrounded or upset by masses of this ice rising under the boats.

PISTON OR HAMMER DRILLS?

By James E. Harding.

The application of hammer drills to flat work, compared to the length of time that power drills have been used for such work, is of recent date. There is but slight difference between the two types of machines when considering the arrangement of valves, etc., the main difference being in the way the power is applied to the steel. In the piston machine the steel is held rigidly in the chuck and the blow is struck by the movement of the entire steel, chuck and piston. In the hammer type of drill the steel is held loosely in the chuck and does not move back and forth, but the blow is struck directly upon the shank end of the steel. Right here comes a point in favor of the hammer drill. It will be readily seen that a large amount of power is lost by the friction of the steel moving back and forth in the hole. Also, in drilling holes with a piston, whether up or down holes, much friction develops from the dust in the one and the mud in the other.

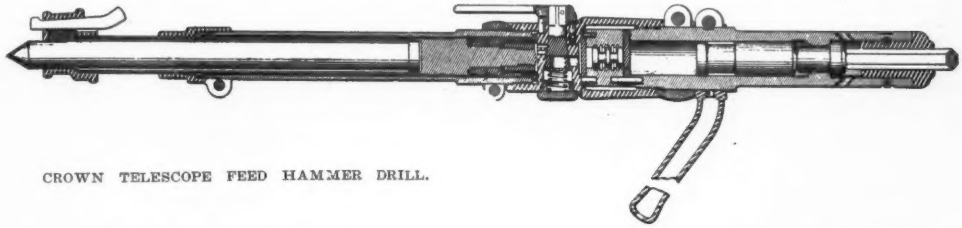
In setting up a column or bar for the two machines, much more care has to be used in case of the piston machines on account of their back kick. A set-up oftentimes that would be kicked down in starting one hole with a piston machine will stand for a round with a hammer drill, which has a big vibration but practically no back kick.

After the set-up is made a drill runner will find that there is much difference in the labor of starting holes. Every man who has run a piston machine knows the pleasure of holding a dancing steel against a slanting surface, with either a chuck wrench or another steel, while a hole is being collared. This difficulty is practically eliminated in a hammer drill, owing to the fact that the steel is not moving and but little difficulty is found in starting a hole on a badly slanting surface.

Then, too, after the hole is collared, the rapidity of the running down is far greater with a hammer machine than a piston. At a contest in Victor, Colo., held July 4, 1910, a hammer drill went through 16 feet and 6 inches in 15 minutes, and, while records are not at hand for piston drills, I very much doubt if there is a piston machine made that would have drilled 4 ft. in the same rock in the same time. The rock was hard Pikes Peak granite, full of biotite mica and orthoclase feldspar.

Practically all the hammer machines made are equipped with hollow steel, through which is introduced into the hole at the bottom, where the cutting is going on, to expel the cuttings, either air or water or a mixture of the two. The use of water or air and water running through the steel seems to be the best, as in that case there is no dust, which has sent so many "hard rock" men to an untimely grave with "miners' consumption." Also this method of cleaning the hole keeps the steel up against clean rock at all times, and the force of the blow is not halted by the steel driving through 2 or 3 inches of thick mud. Perhaps the greatest advantage of this method of cleaning holes comes in drilling "back holes." I have seen more perfectly good time and profanity wasted in twisting or kicking a stuck steel out of a mudded back hole than in almost any other one thing in mining.

The labor of running the different types of machines is not to be compared. I have a definite remembrance of running a machine in a mine in Cripple Creek, driving a crosscut through solid syenite, after which all other rock that I have ever tackled seems soft. In those shifts I do not remember of ever sending up less than 90 pieces of steel, and some days the count would run as high as 140. Now it is an assured fact that a



CROWN TELESCOPE FEED HAMMER DRILL.

chuck tender who has handled that number of pieces in a day will not feet a bit frisky at tally. The average chuck tender will use on an average of two minutes to the change, and in making the above number of changes in a shift it is not hard to see where much time has gone. Practically all the hammer machines use no chuck bolt, the steel being merely inserted in the chuck and given a half turn to catch the ratchet lugs on the shank. Changing steel involves not more than 30 seconds by a reasonably active man. Incidentally, not a single hard lift is involved, such as is required in setting a chuck nut home.

I have seen it demonstrated more than a dozen times that one man on a hammer machine can pull as much rock as two men on a piston machine, and both parties equally good runners. I, personally, know of one case, the El Paso mine of the Cripple district, where an accurate account was kept on flat work and the cost per lineal foot was 33⅓ per cent. less where hammer drills were used than it was where piston machines were used.

Of course all the argument is not in favor of hammer drills. The repair account of the two types of machine is greatly in favor of the piston type. As they are now constructed, the hammer type of machine is rather delicate, and, on the other hand, the piston machine will stand more rough usage and abuse at the hands of unskilled or careless and ignorant miners than any piece of machinery that I have ever seen. I also know of one case where the repair bill of a single hammer machine for a single month amounted to over $280, caused almost entirely by a poor runner. A much higher order of intelligence is required for a runner of hammer drills than of piston machines. One can crank a piston machine by the sound as well as by the feel, but a hammer drill is cranked practically by ear. It gives out a clear, high-keyed ring when running right, and if too close or too far away from the ground the key immediately changes.

An experienced runner on piston machines often gets into difficulty when he tries to run a hammer machine. I recall one instance that I know of in the Blue Bird mine at Cripple Creek. A latest model of hammer machine was running in the south side of one level and an old 2-in. piston machine was running in the north side. The runner of the hammer machine was an old piston man and the runner of the piston machine had had but very little experience in running machines of any sort. The piston machine more than doubled the hammer machine in footage and in the amount of muck broken, and also the piston machine runner had his round in generally an hour before the hammer machine man. So it shows that the ability of either one of the machines to break ground depends largely upon the man behind.

But, altogether, taking the two types of machine, by and large, considering the labor of operation, the expense of unkeep and the amount of ground broken, from the view-point both of a drill runner and an employer in an experience covering several years, I speak my word without an instant's hesitation in favor of the hammer type of machine.—*Mining Science.*

ENORMOUS AND NOVEL COMPRESSOR PLANT FOR THE RAND

The air distribution system being installed on the Rand, South Africa, will be unique, not only on account of its size, the largest in the world, the first installation alone comprising a plant of 40,000 horse power, but also in the type of compressors adopted. These are of the rotary type and will be the largest individual units ever built. The Rosherville station will accommodate four of these turbo-compressors, each of 4,000 h. p. capacity, and

here the prime movers will be steam turbines. Six more turbo-compressors of the same output are to be installed at the Robinson Central Station, but in this case the compressors will be driven by electric motors at 300 r. p. m. Each unit is guaranteed to compress 590 cu. m. (20,835 cu. ft.) of free air per minute, at an atmospheric pressure of 610 mm. (24 inches of mercury, corresponding to an altitude of about 5,800 feet) to a terminal pressure of 9 kg. per sq. cm. absolute (116 lbs., gage, at that elevation). The delivery temperature is not to exceed 85 deg. C. (185 Fahr.). The principal air mains leaving Rosherville Station have a diameter of 24 ins., and the diameters are tapered down to 9 ins. on approaching the consumers' properties. The average velocity in the mains will be about 35 ft. a second. The pipes are of lap-welded steel, with a special joint which has been designed to prevent leakage. The size of the pipes is calculated on a basis of an average drop of about 5 lbs. in the pressure. The total length of pipes installed at present amounts to 19 miles, and the lay-out is so designed as to permit any extensions in the future and the formation of ring circuits for the area supplied.

METERING THE AIR.

In accordance with the contract entered into with the mines, the meters for measuring the compressed air had to be so arranged as to register the energy contained in the compressed air in "air units." In deciding upon the type of air meter the following alternative designs were available: (1) Displacemennt meters, (2) fan meters, (3) meters involving the impact of the moving air upon the plate or surface, (4) meters involving a Pitot tube, (5) meters designed on the Venturi principle. The adoption of the displacement meter was out of the question on account of high initial cost and the large difference of pressure required for operation. The fan meter was undesirable on account of the comparatively short range over which the revolution of the fan is proportional to the velocity of the air, and for other reasons. The impact type of meter was regarded as unsuitable on account of its small range. The use of the Pitot type was thought undesirable partly because the relation between the maximum and the mean velocity in the pipe varies with the rate of flow and the slight irregularities in the surface of the tube which disturb the even spacing of the stream lines, but mainly because of the very small difference of pressure due to the Pitot head which is available for effecting the measurement of the velocity. Meters designed on the Venturi principle are considered to have many advantages for the requirements of the case, among them being the following: The law of flow through the Venturi tubes is precisely known, and the Venturi heads obtainable with 1-10th of a lb. per square inch drop of pressure across the meter allow the flow to be exactly measured with one tube over a range of about 1 to 30. The meter registers the logarithmic functions of the Venturi head, the pressure, and the temperature independently. The addition of these various logarithmic functions is effected by means of a double differential gear. The measurement of the Venturi head is taken by the movement of a light inverted bell, immersed in an oil seal, the throat pressure acting on the underside of the bell and the main pressure acting on the outside. An increase of flow thus causes the bell to sink. The device for measuring the pressure consists of an ordinary Bourdon tube such as is used in pressure gauges; four such tubes are arranged to move the pressure cam in order to ensure an ample margin of power. For the measurement of temperature a small steel bulb containing liquid anhydrous ammonia is placed in the air main, and is connected by means of a flexible steel tube to a Bourdon tube in the recorder. The error introduced into the readings by the change of temperature, if not registered, would be about 1 per cent. for every 10 degrees change. The error introduced by not recording the change of pressure would be 1 per cent. for every 1 lb. per square inch change in the pressure. It will be seen, therefore, that the automatic registration of the changes in pressure is very much more important that the registration of the changes in temperature.

Edison is reported to have said: "The earth has quite a bulk, but it slips through the ether with so little friction that your thumb in the right place could move it." But how far could you move it if you pushed all your life?

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THE ALWAYS READY AIR POWER HOIST

For industrial establishments of any considerable extent a supply of compressed air for general power purposes, that is for the numerous smaller and more scattered power requirements, may be said to have advanced its own status from at first that of a mere convenience to now an actual necessity, and the works which pretend to any standing or which boast any business enterprise and which have not a permanent and reliable supply of compressed air applied to various uses are the exception rather than the rule. Compressed air constantly proves itself an excellent servant for light, widely separated and occasional services, and it shows itself perhaps at its best when used for hoisting purposes. The direct acting single cylinder air hoist, for its instantaneous readiness and its quickness and precision of action, is without a rival in its special field, while the geared motor hoist gives a control of the rate of lowering and hoisting, and an absolute certainty of holding the load at any point and for any length of time, which cannot be surpassed.

In the employment of compressed air for the driving of continuously operated tools or machines there is one particular condition which is generally imperative. It is necessary to have a continuously running compressor, because it is not practicable to store the air in sufficient quantity to last for any length of time. With a compressor of a capacity adapted to its regular load, both production and consumption of the compressed air going on continuously and at an approximately equal rate, the compressor, with the air storage capacity usually provided, can only be said to be about a single minute ahead of whatever it furnishes the air to, so that if it should stop for a minute all the running machinery driven by it might be expected to be out of commission in the next minute.

This one minute of margin, however, constitutes a vast difference from and an advantage over the electric drive, with which there is not a single second of margin. The generator must never stop if what it drives is not to stop. If the generator stopped an electric hoist would be as inert as a watch without a mainspring. When we see a streetful of trolley cars stopped we know that the drive is dead at the power house. The wires will then not supply

current to move a single car any more than to move all the cars on the line. When the generator is started again there must be current enough to move all the cars on the line, and this must be always kept ready for the work no matter how much the cars may be stopping and starting.

For the operating of air hoists, one or many, and whether direct acting or motor driven, the possibility of air storage, although, as said, it is limited, is still sufficient to give the air hoist an important economic advantage. It really takes very little—reckoned in horse powers—for any single operation of hoisting, and the time required for the hoisting is very small when compared with the intervals of rest between, so that a very small compressor running continuously may supply not only one but several air hoists, and without any excessive or expensive storage capacity. In shops where an air supply is maintained for operating pneumatic tools and for the numerous air operated devices now so common, especially in railroad ships, the consumption of air by the hoists is scarcely discoverable. To raise a ton five feet high in one minute requires only a half of a horse power, with liberal allowance for friction and other losses, and this half of a horse power may be furnished by a compressor of one-tenth of that capacity or less allowing it to work right along through the intervals generally occurring between the hoists, while electric power would have to be all there at the moment of hoisting.

We of course are not forgetting the electric traveling crane, but for the incidental hoisting which occurs in all the industries the air hoist has a field of its own which it is quite sure to continue to hold.

WORK OF THE BUREAU OF MINES*

The Bureau of Mines was created by Congress as the result of a demand coming not only from the mining industry, but also from the general public in different parts of the country. The chief purpose of the Bureau of Mines is the development of greater safety and efficiency in mining. It may be expressed in another way as "lessening the loss of life and the waste of resources" in connections with the operations of the American mining industry. Or, as expressed in a yet different way, its chief purpose is the "conservation of the lives of the miners and the mineral resources of the country."

If, in view of the fact that the Bureau has no means of enforcing and carrying out its recommendations, the question is raised as to how it can aid in the accomplishment of these purposes, it may be said in answer that the Bureau neither needs nor desires any authority, except that based upon an enlightened public opinion. The Bureau will endeavor to aid in carrying out these purposes by conducting investigations and inquiries into the best mining and treatment practices to be found in different mining countries, and into the fundamental chemical and physical problems that serve as a basis for more efficient metallurgical operations. It will thus endeavor to indicate how all branches of the industry may become both safer and less wasteful; but the Bureau will leave to other agencies the enforcement of new requirements, or even the adoption of its recommendations. It will publish the results of its investigations and inquiries in such form as to make them easily interpreted in daily mining practice in the United States.

The new Bureau will do everything it can do to encourage each State in the investigation of its own local mining problems, and in the proper inspection and supervision of the mines operating within its borders. It will do everything possible to help maintain and increase the influence and effectiveness of the State Mine Inspector. It will endeavor to co-operate with, but not to belittle or supplant, the work of the State. Similarly, it will do everything within its power to encourage private mining corporations to investigate their own local problems, and to properly inspect their own mining operations, with the view of lessening the loss of life and waste of resources. It will itself take up inquiries and investigations in which the National Government as such is a party at interest, and to those other problems in relation to the mining and treatment of our mineral resources that are general in their application, or national in their importance. The Bureau will

*From an address by J. A. Holmes, Director of the Bureau, at the session of the American Mining Congress, Los Angeles, California, September 28, 1919.

in this way endeavor to minimize the responsibility of the Federal Government; and to minimize the contribution which the Federal Treasury may be called upon to make in behalf of a proper development of the mining industries. In the wise development of our two great foundation industries, agriculture, and mining, which are alike essential to the present and future welfare of the Nation, the Federal Government, the State, and the private individual or corporation each has its responsibility and its duty, which responsibility and duty no one of them should shirk.

The work of the new Bureau should not diminish the work of the private mining engineer, but, on the other hand, should increase his work by pointing out to mine owners additional problems which he should be called upon to solve at the cost of the parties most interested. Such has been the result of the preliminary work conducted by the Technologic Branch of Geological Survey during the past few years, and a similar result should follow the work of the Bureau of Mines.

Every one responsible for the establishment of the Bureau of Mines realizes the fact that its first duty is to aid in lessening the loss of life in mining. Those associated with the work of the Bureau realize that the mine owners of this country are in full sympathy with this purpose, and that they stand ready to put into practice, as far as conditions will permit, every practicable recommendation and suggestion that the Bureau may have to make. On the other hand, the people of this country are beginning to realize that many of the methods practised and appliances used in other countries, where profits of mining, and especially of coal mining, are far greater than in the United States, can not easily be introduced into the United States, because their cost would exceed the profits of the industry here; as no industry can operate on a basis of financial loss. Nevertheless, progress is being made, as shown by the fact that the loss of life in the American mines has decreased more than 25 per cent. during the past two years.

The appeal of the new Bureau is therefore to every man connected with the mining industry in this country, to the mine worker, the inspector, and the mine owner alike, that he do everything that can in reason be done to safeguard the lives of the men who labor underground; to see that the disasters at Monongah, Darr, Marianna, and Cherry shall have no counterpart during the winter of 1910; and that the daily toll in the lives of miners from other causes, less impressive, but in the aggregate more destructive than these awful disasters, shall steadily diminish.

In the demand for the creation of this Bureau, the mine owners and mine workers alike have joined. Let no one of these suppose for one moment that with the establishment of the Bureau his work has ended; for in reality it has only just begun. It is only under the good advice of those most familiar with all branches of mining that wise leadership by the new Bureau can be properly developed; and the Director of the Bureau will welcome such advice.

In the competitive branches of the mining industry, such as coal mining, the lawmaker also must contribute by helping to improve the economic conditions which now hinder wise practice and development. All these agencies must co-operate if the mining industry as a whole is to reach that higher standard of safety and efficiency which should characterize this American industry, and to which we look forward with full hope of accomplishment. There are many difficulties in the way, and the path will not in all cases be plainly marked. There will be differences of opinion, both as to what should be done, and as to the mode of procedure. But the Director of the new Bureau wishes the members of the American Mining Congress, and mining men throughout the country, to know that their sugestions and advice will be welcome always, even if it cannot always be followed. He realizes that this Bureau is not his, but yours, and his highest aim will be to render a disinterested loyal service to the mining and metallurgical industry in all its branches, in all parts of this country.

PROGRESS ON THE BARGE CANAL

Rapid progress was made during the past year in constructing the New York State Barge Canal. At the end of 1909 76 per cent. of the total length had been placed under contract and it is expected that the whole of it will be let by April 1 next. The total length of the Barge Canal system, exclusive of the Niagara River, which is being improved by

the federal government, and the Hudson river below Waterford, which it is anticipated the government will improve, is 433 miles. Of this amount at the end of 1909 314.2 miles were under contract at prices aggregating $54,138,329. In addition plans for 67.7 miles had been completed, plans for 9 miles more were over 75 per cent. finished and the plans for the remaining 20.5 miles were well under way. Of the 53 new locks 15 had been completed at the end of the year, with the exception of gates and operating machinery. By a year from next spring it is expected that the eight movable dams in the Mohawk River will be in operation and will be used to aid in the dredging of the channel, by retaining water for the floating of dredging machinery. The large fixed dam across the Mohawk River near Crescent will be finished during next summer, as will also the concrete dam impounding the waters of the upper Mohawk at Delta in a reservoir having a flooded area of 2,800 acres.

An important feature of the Barge Canal work is that it is being done within the original estimates. The estimates made in 1903 for construction on the portions of the canal now under contract amounted to $56,791,537, while the contract price for this work as revised by alterations was $54,138,329, or $2,653,208 within the original estimates.

CHARLES T. PORTER

I feel impelled to offer my word of tribute to the memory of Charles T. Porter. The rushing world had, in a way, swept past him. He belonged to the Nineteenth rather than to the Twentieth Century, and was no longer under the spot light. And yet he was undoubtedly one of the world's great engineers and had been especially an epoch maker in engineering progress.

Last year he was the fifth one to receive the John Fritz medal "for notable scientific or industrial achievement." This honor had been eminently well bestowed in each preceding case, and the latest recipient was in no way less entitled to it than any of his illustrious predecessors. The general up-to-date public perhaps knew his name somewhat less familiarly than it knew the others, but the engineering world knew him well, although few, after all, realized the magnitude of the world's indebtedness to him.

The formal award of the John Fritz medal in Mr. Porter's case was for his work in the development of the modern high-speed engine. He revolutionized steam engineering, and the later developments of the power house, and the special applications of steam in the rolling mill, in marine service, in the vast electric field, and practically wherever steam is economically employed for power development, were led up to and made possible and actual by him.

And all this came not as the result of a single happy thought or of one great invention, but from a changing and adapting and originating of many details. The original Porter-Allen high-speed engine was not an invention, but an aggregation of inventions, and in its designing the inventive faculty was constantly alert and resourceful. There was novelty of invention in the valve, in the valve motion and in the governor. The frame and bearings were novel and original. The making of the reciprocating parts very heavy instead of light was, at the time, perhaps, the most astonishing feature of all. For the original and independent inventions involved, Mr. Porter was always careful to insist that Mr. Allen should have full credit.

Not only was the inventing and designing task most exacting, but the requirements of construction were little less so. High-speed engine practice produced a revolution also in shop practice, and Mr. Porter became a pioneer in precise workmanship as it is known to-day, not only insisting upon minute accuracy and finish, but also devising the ways and the means for such production. While the modern, precise methods of manufacture, and the almost absolute identity of parts produced cannot be credited to any one or to any dozen selected men, Mr. Porter was among the first and most insistent and most successful of modern manufacturers, and in his line no more excellent workmanship has ever been achieved. Mr. Porter not only thus taught the tricks of high speed and of precision in manufacture, but he pushed others, no doubt often unknowingly, to notable engineering and manufacturing achievements.

As another consequence of high-speed engine developments and requirements, Mr. Porter became the begettor of the first efficient and satisfactory high-speed steam-engine indicator, he having stimulated Charles B. Rich-

ards to its production, and then Mr. Porter's book in exposition of the indicator and of indicator practice brought out his remarkable talent as a clear and forcible and most readable writer. My first acquaintance with that book worked a new departure in engineering knowledge and imparted an interest in steam engineering never felt before.

Mr. Porter's high success in so wide a reach of activity is most unaccountable, according to the story which he has told us. His early predilections and associations do not seem to have been at all in mechanical or engineering lines. I tried more than once to learn from him something of his early years, but without success. He was educated and prepared for other things and had begun life as a fully equipped lawyer, when directly through that he was brought face to face with his life work, so different, but which he would seem to have plunged right into without any of the usual time serving or ordeal of preparation.

If his success was so unaccountable, his unsuccess in securing any of the substantial rewards of life for which man strives would seem to be not less so. One might have thought that in this the legal training and experience should have helped him, but it seems not to have availed at all.

I knew Mr. Porter only for a score of years, and that after, as we may realize now, all his notable things had been done, although his head was still full of schemes. It was always a pleasure to meet him. He was genial and helpful and always highly appreciative of every little thing that could be done or said in evidence of one's well-wishing. He did much good work, which is enduringly embodied in the world's engineering history.—Frank Richards, *American Machinist.*

"PAY AS YOU ENTER" FOR COALING SHIPS

At Kingston, Jamaica, a novel method of coaling ships and of the payment of the laborers is resorted to. When a ship is to be coaled a hundred or more negroes gather and wait for the signal to start. They are furnished with full baskets (about 1½ bushels each) of coal, which they carry on their heads from the coal yard to the coal bunkers, where the basket is dumped and the empty basket carried back. Each laborer receives a penny a basket, and as he passes up the gang plank with the load on his shoulders, a penny is handed him by the negro "paymaster." Of course labor is plentiful, but the prospect of receiving money each trip has proved the most effective stimulant yet devised.

NEW BOOK

Compressed Air Plant. The Production, Transmission and Use of Compressed Air, with Special Reference to Mine Service, by Robert Peele. John Wiley & Sons, New York. XVI—502 pages, 6x9 inches. 209 cuts. $3.50 net.

This second edition of Prof. Peele's book, following the first so closely, shows that it has won deserved recognition. It is an eminently practical book and should be of value not only to miners, but to all who have to do with compressed air. In addition to a revision of the whole the new matter comprises 174 pages and 97 cuts.

NOTES

California oil production for the first half of 1910 totaled 36,784,364 bbls., 9,188,341 bbls. coming from the Coalinga district.

Heat received by the earth under a high sun and a clear sky is equivalent, according to the measurements of Langley, to about 7,000 h. p. per acre.

Minnesota furnishes from St. Louis county alone about three-fifths of the iron ore produced in the United States; the shipments during 1909 amounting to 29,282,526 tons.

By mailing a request to the Director of the Bureau of Mines, Washington, D. C., the various publications may be otbained, and also advance notices of bulletins and other papers to be issued.

Owing to the increasing popularity of the automatic ticket delivery machines which have been placed in the London Tube and District stations, the management of the Bakerloo, Piccadilly, and Hampstead lines have ordered 25 more, making 50 in all. Recently 76,000

tickets were issued by the machines in one week.

An explosion of corn dust occurred at the works of the Corn Products Refining Co., Granite City, Ill. The explosion was on the sixth floor of a building where several workmen were engaged in sacking the corn dust as it came from the refining plant, about 100 ft. away. Two men were killed and seven others fatally injured.

Manufactures now form, for the first time in the history of our commerce, more than one-half of the total exports of the United States. In the 8 months ended with August, the figures of the Bureau of Statistics of the Department of Commerce and Labor show that out of a total exportation of $1,027,000,000, manufactures amounted to $542,750,000, or 52.8 per cent. of the whole.

For use during cold weather, when the trains of the Pennsylvania railway entering the New York station through the electrified-tunnel zone are disconnected from their steam locomotives, steam generated in electric boilers will be used to maintain the temperature in the cars and to keep the train connections from freezing. These boilers will utilize the 600-volt direct current from the third rail, generating steam at 80 pounds pressure.

One of the latest automobile novelties in England is a tire pressure gauge which measures the pressure that is actually in the tire. It is about the size of a pencil, and is aplied to the valve after unscrewing the valve caps. A small pin depresses a valve plunger and the air forces out a little piston on which the pressure is plainly marked in pounds. The correct pressure for different sizes of tires is printed on the gauge. The device is so small that it can be carried in the vest pocket.

The introduction of compressed-air pipe lines into all the workings of a mine might be utilized to provide fresh air and even food to men imprisoned after explosions or through falls. This does not involve much expense, as mines are usually equipped with compressed-air apparatus, and the piping leading into the mine is of such a nature as to withstand considerable damage from the exterior. Telephone wires inserted within the air pipe might also serve a useful purpose in saving life.

A new tunnel under the East River, New York, will be driven from Astoria, Long Island, to 132d Street and Locust Avenue, Borough of the Bronx, for the Consolidated Gas Company. It is to pierce the rock about 250 feet below tidewater level. The section planned is 19½ ft. wide and 19½ feet high, with a circular roof and vertical side walls about 8 feet high. It is to be lined with concrete and will contain two 72-in. gas mains set in concrete in the bottom.

In view of the fact that there are other substances in nature besides air that contain oxygen, and will give up this oxygen to combustible substances, it would seem probable that combustion could be brought about through the aid of such oxygen-containing bodies; and this was long ago proved to be true. One of the first, if not the first, of such bodies that became known to man is saltpeter, also called niter, or potassium nitrate, which, because it occurs as a white efflorescence like frost on the surface of the soil in India, has been called India saltpeter, although it has been found to some extent in many parts of the world.

The synthesis of hydrogen and nitrogen has hitherto been deemed impracticable, because of the slow reaction of nitrogen at low temperatures and its very slight affinity for hydrogen, even at high temperatures under ordinary conditions. Experiments made in Germany, however, are said to show that by the use of a pressure of about 200 atmospheres, which is considerably higher than previously employed, combination readily takes place especially with the aid of osmium or uranium as a catalytic agent. This principle is the basis of a new process for the fixation of atmosperic nitrogen in the production of ammonia. Other processes for the fixation of atmospheric nitrogen involve the use of the electric arc.

The last addition to the world-wide campaign of upper-air research, is the work in this line just begun at Cordoba, Argentina, under the direction of the meteorological ser-

vice of that country. The work was organized by Mr. C. H. Clayton, late of the Blue Hill Observatory. An aerological staff of five observers is now making, so far as conditions permit, daily observations with kites, and will later undertake balloon observations. The aerological station at Cordoba is notable as the only institution of its kind in South America, and with the possible exception of Samoa, the only place in the southern hemisphere at which regular and frequent soundings of the upper air are in progress.

What is described as the largest stalactite cave in Europe was recently discovered near Schoenbergalm, in the Dachstein mountains, Upper Austria. Recently a party of Austrian and Hungarian scientists spent twenty-four hours in thoroughly exploring the cavern. The principal tunnel was found to extend over a mile and a-quarter, with numerous side passages of varying lengths. In traversing the main tunnel the exploring party had to cross by rope ladders an ice crevasse 75 ft. deep and more than 100 ft. wide. The cave is divided into two levels. In the upper were found two immense ice-halls containing precipitous subterranean glaciers some 300 ft. long. Phenomenal ice formations were also found here. In the lower level was an endless series of halls, the largest more than 600 ft. long and 100 ft. high. Traces of subterranean water courses in the form of sand and rubble were discovered in the main tunnels. There were also some beautiful flower-shaped stalactites. Among the palæontological discoveries made were petrified Brachiopoda and remains of cave bears (Ursus spelæus).

LATEST U. S. PATENTS

Full specifications and drawings of any patent may be obtained by sending five cents (not stamps) to the Commissioner of Patents, Washington, D. C.

OCTOBER 4.

971,517. FLUID-MOTOR. CARLOS F. BENITEZ, Guadalajara, Mexico.

971,535. AEROPLANE. HERMANN HARTMANN and WILHELM KLEHE, New York, N. Y.

971,537. MILKING-MACHINE. JOHN L. HULBERT, Holland Patent, N. Y.

3. The combination in a milking machine of a rigid cylindrical teat cup shell, a plurality of inflatable tubes in the shell encircling the teat chamber thereof, a closure for the lower end of the teat chamber adjustable into the chamber, means for applying an intermittent suction to the lower end of the teat chamber, and means for supplying fluid under pressure to said inflatable tubes and deflating them, substantially as set forth.

971,583. PNEUMATIC SPRING. BENJAMIN BELL, Philadelphia, Pa.

971,595. VACUUM-CLEANER. ARCHER E. CLIFTON and WORTH W. PRESTON, Connersville, Ind.

971,609. PROCESS OF CLEANING AND SEPARATING GRAINS. AXEL T. HEDFELDT, Chicago, Ill.

The process of separating granular material which consists in spreading the same out into a thin film, feeding such film over a supporting perforated body transversely to an air current, subjecting such thin supported and spread out film of material to a confined current of air forced against it from below, passing such current of air with the material to be separated from the film space along a confined upwardly and laterally extending path, and discharging the material therefrom at intervals depending upon the weight of the materials.

971,612. APPARATUS FOR FORCING FLUIDS FROM WELLS. WILLIAM C. HOLLIDAY, Columbus, Ohio.

1. In an apparatus for forcing fluid from wells, the combination with a well, a casing therein, a discharge pipe extending into said well, a plurality of plungers in said discharge pipe having a limited downward movement, each of said plungers having a vertical valve controlled passage, a valve and valve casing below the plungers, and a plurality of air pipes leading into said discharge pipe between the discharge pipe valve and the plunger, said air pipes having valve controlled connections with the compressed air supply.

971,638. AIR OR STEAM ROCK-DRILL. JOHN REDINGTON, Cobalt, Ontario, Canada.

971,660. ROTARY PRESSURE-BLOWER. PERCY D. BREWSTER, East Orange, N. J.

971,743. VACUUM-SWEEPER. RICHARD GOBER, Alameda, Cal.

971,806-7-8. COMBINED AUTOMATIC AND STRAIGHT-AIR BRAKE. WALTER V. TURNER, Edgewood, Pa.

971,839. WASHBASIN. JAMES HARTNESS, Springfield, Vt.

1. The combination with a bowl, and a permanent trap whose limbs are not less in altitude than the desired maximum water column in the bowl, of an intermediate drainable trap having an air chamber whose volume is not less than the volume of the inlet limb of the permanent trap, said trap comprising a fixed air containing chamber, and a displaceable trap member movable relatively to said chamber.

971,894. FILLING-MACHINE. LUDWIG JAEGER, Chicago, Ill.

1. In a bottle filling machine, the combination of a liquid tank, a liquid valve, an air connection between the tank and the bottle being filled to permit an equalization of pressure in the bottle and tank before the liquid flows into the bottle, and means for controlling the escape of air from the bottle during the filling operation to enable the liquid to flow into the bottle at a constant velocity regardless of the loss of hydrostatic head during the filling operation.

971,896. COMPRESSED-AIR SYSTEM FOR RAILWAY-CARS. OSCAR JOHNSON, Chicago, Ill.

971,913. DENTAL AIR-PUMP. EDUARD MESSMER, Gratz, Austria-Hungary.

971,933. PNEUMATIC STACKER. JOSEPH K. SHARPE, JR., Indianapolis, Ind.

971,982. PRESSURE-REDUCING VALVE. THOMAS P. FORD, New York, N. Y.

971,984. SAFETY SYSTEM FOR REFRIGERATING APPARATUS. ALBERT GAIDE, Chicago, Ill.

1. The combination in a refrigerating apparatus, of a compressor; inlet and outlet pipes for said compressor; a check valve in the outlet pipe; a valve in the inlet pipe arranged to stop the passage to the compressor; a differential piston and cylinder; an operative connection be-

tween said inlet valve and said piston so arranged that the action of the larger piston unseats said valve and the action of the smaller piston seats the valve; an open connection between the outlet pipe on the compressor side of said check valve and the larger cylinder; and an open connection between said outlet pipe on the other side of said check valve and the smaller cylinder, substantially as described.

972,027. AIR-BRAKE MECHANISM. HUGH T. RYDER and JOHN P. JOHNSON, Greensboro, N. C.

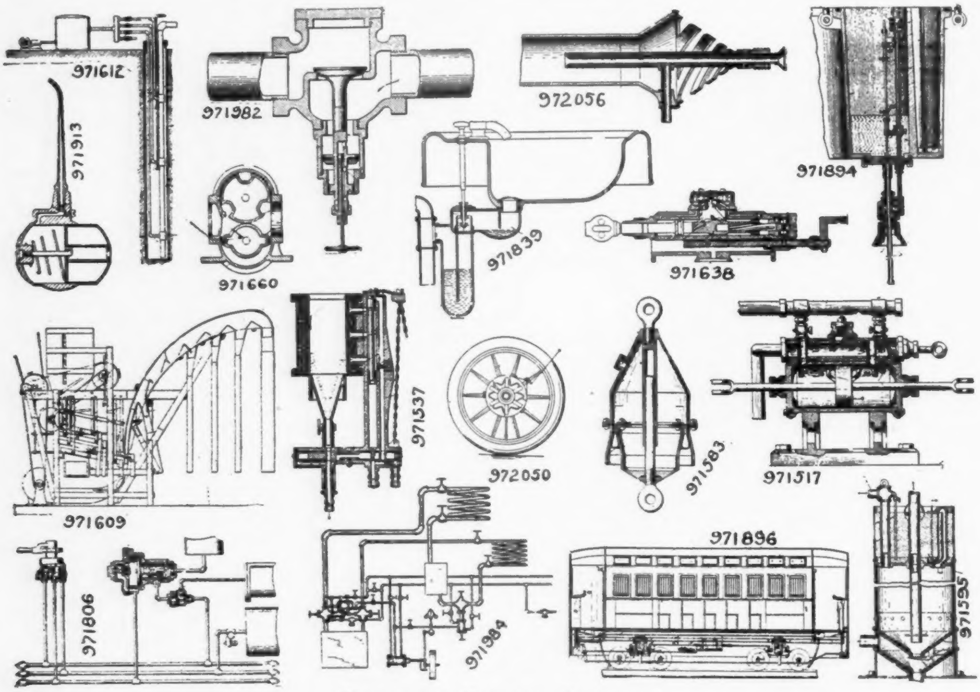
972,039. HYDRAULIC AIR-EXHAUST MECHANISM. JOHN WILLIAMS THOMAS, Allentown, Pa.

972,050. TIRE-INFLATING DEVICE. ROBERT BARNFATHER, Croydon, England.

1. An inflator comprising a frame, a series of cylinders mounted upon said frame, suction and delivery valves to said cylinders, a reservoir into which each cylinder delivers air, a drum concentric with said frame, said drum being external of the series of cylinders and said reservoir being internal of said series, a cam surface upon said drum, pistons fitting in said cylinders, connections from said pistons to said cam surface, and means for causing relative rotation between said frame and said drum.

972,056. NATURAL-GAS BURNER. CHARLES E. BUNNER, Grafton, W. Va.

1. A burner of the class described comprising a tubular body open at one end, a conical head on the inlet end of the body, said head having air inlet ports, a conical valve rotatably mounted on the head and having inlet ports adapted to be moved into or out of register with the ports of the head, a centrally-disposed longitudinally-extending pipe terminating within the said body, means for connecting the pipe with a source of gas, means for imparting a whirl to the gas while in the said pipe, and a deflector for distributing the gas into the air passing through the said body.



PNEUMATIC PATENTS OCTOBER 4.

OCTOBER 11.

972,161. AIR-COMPRESSOR. ALLAN O. CARPENTER, Franklin, Pa.

4. In combination with an air compressor and its inlet port and inlet valve therefor, an unloader valve governing a portion of the inlet port and adapted to maintain such port open, and a fluid pressure governor actuated by the excess pressure delivered by the compressor for operating the unloader valve.

972,163. AIR-COMPRESSOR. WALTER L. CRANE, Denver, Colo.

972,183-4. AIR-FILTER. CARL GUNTRUM, New York, N. Y.

972,212. PNEUMATIC COTON-SEED SEPARATOR AND CLEANER. THOMAS MCDONALD, Dublin, Tex.

972,218. CONTROLLING DEVICE FOR PRESSURE-FLUID ENGINES. ALMON E. NORRIS, Cambridge, Mass.

972,223. FLUID POWER TRANSMISSION AND CONTROLLING APPARATUS. WILLIAM E. PEARSON, Boston, Mass.

972,285. ACETYLENE-GENERATOR. FRANK E. STOVER, Luray, Va.

972,294. PROCESS OF CLEANING OLD PAPER-STOCK. JOHN D. TOMPKINS, Valatie, N. Y.

2. The process of cleaning old paper stock which comprises conveying the stock forwardly over one or more large openings and simultaneously removing the strings and then freely fluttering the stock above said openings by means of an air blast, to remove heavy foreign materials by allowing the latter to pass through said openings.

972,347. PRESSURE-REGULATOR FOR AIR-BRAKES. DAVID H. DOWNEY, Basalt, Colo.

972,381. PNEUMATIC-DESPATCH-TUBE APPARATUS. CHESTER S. JENNINGS, Boston, Mass.

972,390. AIR-PUMPING ATTACHMENT FOR WATER-PUMPS. CALVIN H. MERRILL, Shenandoah, Iowa.

972,408. VALVE MECHANISM FOR AIR-COMPRESSORS. THEODORE H. SMITH, San Francisco, Cal.
972,437. PNEUMATIC STACKER. GEORGE F. CONNER, Port Huron, Mich.
972,448. FLYING-MACHINE. JOHN EMERY HARRIMAN, JR., Brookline, Mass.
972,548. HANDLE FOR PNEUMATIC DRILLS. AXEL LEVEDAHL, Aurora, Ill.
972,614. REGULATION OF AIR-SUPPLY IN DRAWING GLASS CYLINDERS. ROBERT L. FRINK, Cleveland, Ohio.
13,155 (Reissue). PNEUMATIC CLEANSING APPARATUS. ALBERT L. MOORHEAD, San Francisco, Cal.

3. In pneumatic cleansing apparatus, a hollow base, having a collecting-tank or receiver therein, an air-compressor pump and an air-exhaust pump mounted thereon, a compressed-air receiver, a pipe connection between said compressor-pump and said receiver, a pipe connection between said exhaust-pump and said tank, an outlet for said exhaust-pump, an air inlet for said compressor pump, an inlet-pipe for dust and refuse connected with the tank, into which it discharges, and a device for agitating and forcing said refuse into said tank between the tank and said inlet-pipe, substantially as described.

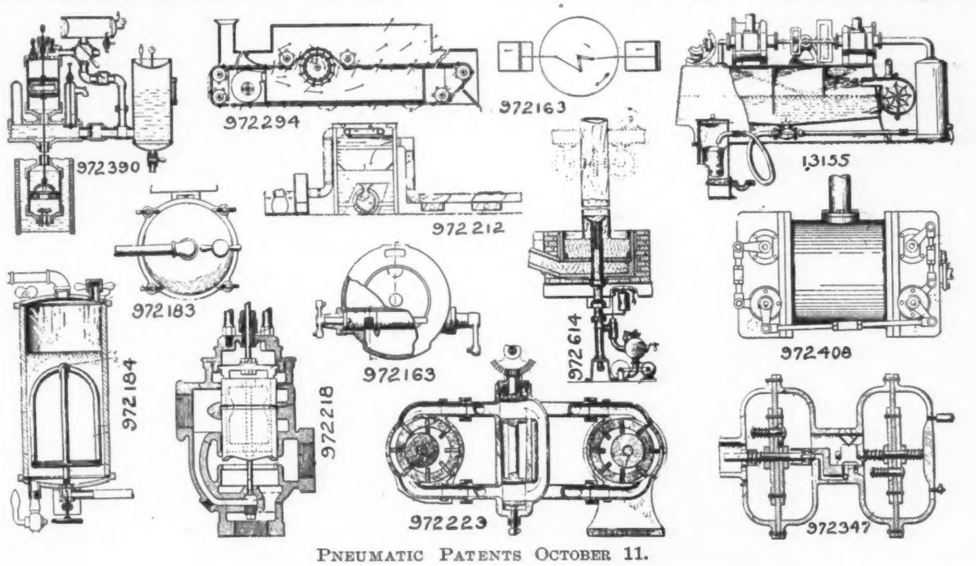
justable to thereby vary the direction taken by a stream of air issuing therefrom; and a connection between each nozzle and said pipe and through which air may flow from said pipe to each of said nozzles.

973,179. AIR-BRAKE SYSTEM. ARTHUR DOAN, Elmhurst, Cal.
973,194. AIR-BRAKE. JOHN E. HENRIS, San Francisco, Cal.
973,211. VALVE MECHANISM FOR AIR-COMPRESSORS. GEORGE H. REYNOLDS, Mansfield Depot, Conn.
973,223. AIR-SPRING. ARCHIBALD SHARP, Westminster, London, England.
973,263. APPARATUS FOR FREEING WATER FROM ITS CONTAINED IRON IN A CONTINUOUS CIRCUIT. LUDWIG HEINRICH DARAPSKY, Hamburg, Germany.

1. In an apparatus for purifying water, a closed filter, a closed separator for air and water separate from the filter and into which the filter discharges, means to pump air from the separator to the filter and means to supply water to the filter with the air.

973,289. FLUID-PRESSURE HEAT-ENGINE. JEAN MOLAS, London, England.

4. Liquid fuel burning apparatus for the production of heat for generating steam, compris-



PNEUMATIC PATENTS OCTOBER 11.

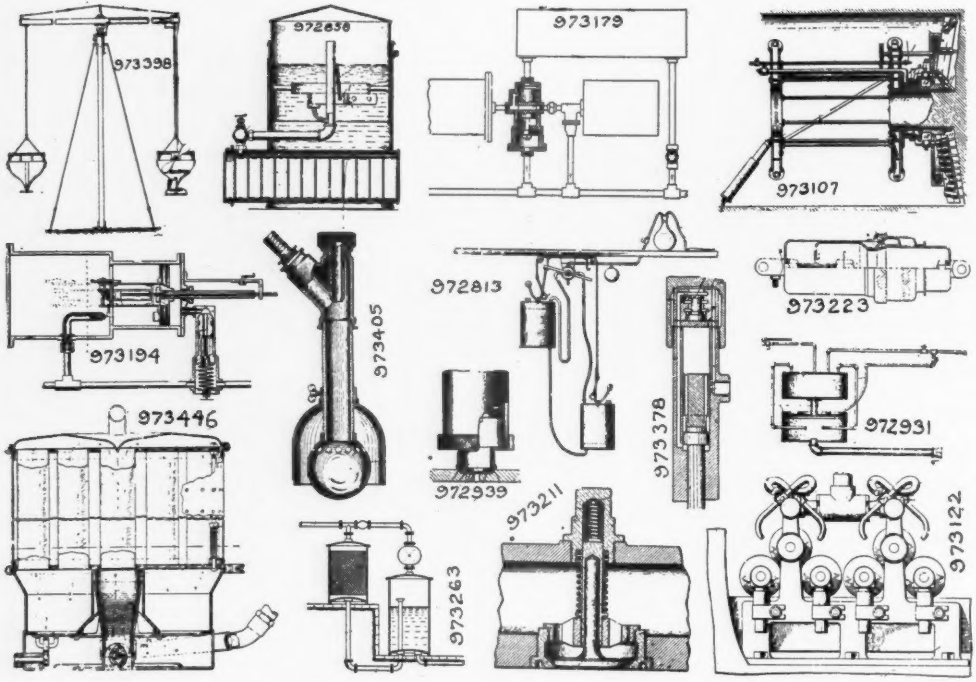
OCTOBER 18.

972,813. AIR-COMPRESSOR. JARVIS R. BURROWS, Chicago, Ill.
972,858. APPARATUS FOR GENERATING ACETYLENE GAS. SAMUEL F. HODGES and WILLIAM H. LEE, Nocona, Tex.
972,931. LIQUID-FUEL BURNER. HOOKER SHAPEL, Iola, Kans.
972,939. VACUUM-PUMP. GRAY STAUNTON, Evanston, Ill.
973,107. TUNNELING-MACHINE. WILLIAM RUSSELL COLLINS, Georgetown, Colo.
973,113. PNEUMATIC STACKER. ALBERT M. HARRIS, South Bend, Ind.
973,122. COOLING APPARATUS FOR INKING-ROLLERS. EDWARD R. MELTON, Washington, D. C.

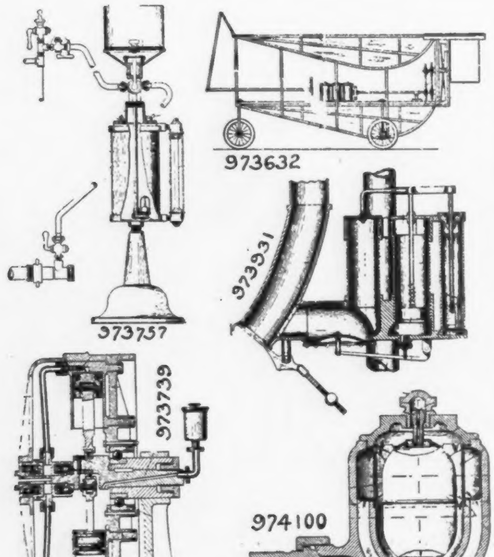
1. In a cooling device for the inking mechanism of printing presses, an air pipe located adjacent the inking mechanism and extending transverse to the press; means through which the air is supplied to said pipe; a plurality of nozzles adapted to direct streams of air against the inking mechanism and each of which is ad-

ing the combination of a reservoir, an internal combustion motor, means driven by said internal combustion motor for compressing atmospheric air, a container adapted to receive air compressed by said air-compressing means, said internal combustion motor, said air-compressing means, and said container being immersed in said reservoir, an inlet to said internal combustion engine and a pipe connecting said container to said inlet, and a pipe connecting the combustion chamber of said internal combustion motor to said reservoir, substantially as described.

973,292. VACUUM-CLEANER. IVER NIELSEN, New Rochelle, N. Y.
973,378. PNEUMATIC HAMMER. FRIEDRICH ADOLF OTTO, Remscheid, Germany.
973,398. CAPTIVE AIRSHIP MECHANISM. VINCENT C. DE YBARRONDO, Los Angeles, Cal.
973,405. VACUUM-PRODUCING DEVICE. SAWYER D. CLARK and CHARLES F. BARTELL, Boulder, Colo.
973,446. PNEUMATIC CLEANING APPARATUS. FRANK J. MATCHETTE, CHARLES GORDON, and CHARLES MOUKOS, Milwaukee, Wis.



PNEUMATIC PATENTS OCTOBER 18.



PNEUMATIC PATENTS OCTOBER 25.

OCTOBER 25.

973,483. ART OF AND APPARATUS FOR CASTING FLUID METAL. HERMAN H. DOEHLER, New York, N. Y.

1. The herein described process, method or art of casting fluid metal consisting of pouring a measured quantity of molten metal from within an inclosed chamber into a metallic mold and thereafter forcing and compressing the metal by following it up with an elastic fluid under high pressure.

973,632. AEROPLANE. JOHN M. DAVIS, McGraw, N. Y.

973,704. MILKING DEVICE. AXEL SABROE, Hadersleben, Germany.

1. In a device for the purpose described, a receptacle, a milk conduit connected therewith near the upper end thereof, a pneumatic pipe connected therewith near the bottom end of less area than said conduit, and an elastic member at the top of said receptacle serving as a closure therefor and also for closing said conduit.

973,739. AIR-COMPRESSOR. GEORGES PROSPER OCTAVE ALVERGNAT, Paris, France.

973,748. PNEUMATIC STACKER. WILLIAM W. BROWER, Harmattan, Alberta, Canada.

973,757. BEER-RECLAIMER. JOSEPH H. CHAMP, Cleveland, Ohio.

1. The combination with the top air inlet and liquid inlet of a bottling machine; of reclaiming apparatus comprising a receptacle having an exteriorly opening liquid inlet and an air vent, and a fluid pressure inlet and liquid outlet respectively connected with the top air inlet and the liquid inlet of said machine; and means adapted to simultaneously control the inlets, outlet, and vent of said reclaiming apparatus.

973,931. VACUO DESPATCH SYSTEM. EDGAR FLINT, Toronto, Ontario, Canada.

974,100. STEAM, AIR, AND WATER TRAP VALVE. JOHN E. BOEGEN, Berwyn, Ill.

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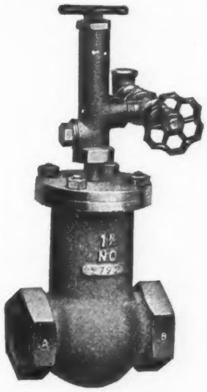

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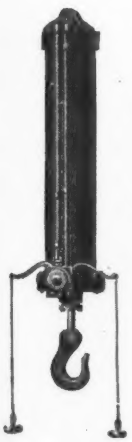

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